R E P O R T R E S U M E S

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VOCATIONAL TALENT EXERCISES, PART D.

GEORGE WASHINGTON UNIV., WASHINGTON, D.C.

REPORT NUMBER BR-5-0061 PUB DATE 66

CONTRACT OEC-5-85-023

EDRS PRICE MF-$0.~~50~~ 25 HC-$2.48 60P.

DESCRIPTORS- *WORKBOOKS, *VOCATIONAL APTITUDE, JUNIOR HIGH SCHOOLS, READING COMPREHENSION, VISUAL DISCRIMINATION, ABSTRACT REASONING, APTITUDE TESTS, *MECHANICS (PROCESS), *PREVOCATIONAL EDUCATION,

THIS WORKBOOK WAS DEVELOPED IN A CURRICULUM PROJECT, DESCRIBED IN VT 004 454, TO HELP YOUNG PEOPLE LEARN BASIC PRINCIPLES AND CONCEPTS OF MECHANICS AND TECHNOLOGY BY MEANS OF A SERIES OF APTITUDE TRAINING EXERCISES. IT IS THE LAST OF FOUR BOOKS WHICH PRESENT 30 EXERCISES DESIGNED FOR 30 CLASS PERIODS. THE EXERCISES ARE SIMILAR TO APTITUDE TEST ITEMS EXCEPT THAT AN EXPLANATION IS PROVIDED FOR THE PRINCIPLES INVOLVED. EXERCISES IN THIS BOOK COVER ABSTRACT REASONING, TECHNICAL COMPREHENSION, AND THREE-DIMENSIONAL VISUALIZATION FOR MECHANICAL AND ELECTRICAL PRINCIPLES AND MACHINES. ITEMS ARE MULTIPLE CHOICE OR COMPLETION QUESTIONS. ANSWERS ARE AVAILABLE IN VT 004 463. OTHER RELATED DOCUMENTS ARE VT 004 455 TO VT 004 471. (EM)

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VOCATIONAL TALENT EXERCISES

PART D

The George Washington University
School of Education
Education Research Project
Washington, D.C.
1966

VT004462

INTRODUCTION

Several important talents have been found to be very necessary for success in training for good jobs with a future. Your ability in these skills may be measured and used at different times during your lifetime as indicators of your chances of success. Therefore, how well you do in life may depend upon how well you master these exercises.

This booklet is the fourth in this series and continues the exercises of Parts A and B Part C contained exercises very similar to those in this booklet. Practice in doing these exercises should increase your ability to succeed in important training programs later on.

The answers to these exercises have been printed separately and supplied to the teachers only.

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TECHNICAL COMPREHENSION

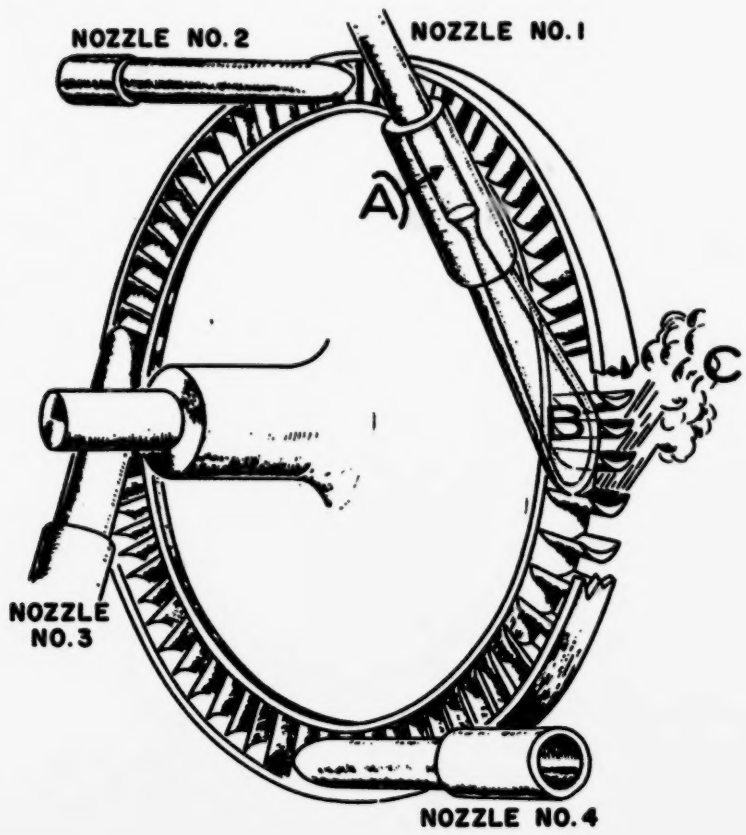
Four of the exercises in this booklet are intended to sharpen technical comprehension abilities. They are Exercises 24, 26, 28, and 30. They are very much like the exercises about technical things in Part C of the Vocational Talent Exercises.

Each exercise is in four parts. Each part concerns a different application of mechanical or electrical principles and machines. There is a picture or a diagram of the device, followed by a brief description of how the device works. The student should learn the new words given on the picture and in the text. Then there is a series of questions to be answered with reference to the picture and the description.

It is not possible in this short space to describe any of the devices fully. Further details can be obtained from books on physics, electricity, or electronics. Students are encouraged to look up more information about those devices that interest them.

Exercise 24
No. 1

SIMPLE IMPULSE TURBINE



Impulse steam turbines use the force of a steam jet to drive a shaft. A toy pinwheel turns from the force of a stream of air. The harder the air blows the faster the pinwheel turns. The steam turbine works on the same principle.

The turbine wheel shown has four nozzles. Steam from these nozzles strike against the curved blades. The whole assembly is enclosed in an airtight case.

As the steam passes through each nozzle its pressure is greatly reduced, but its velocity is greatly increased. It is the force of the high-speed steam that turns the blades and the shaft.

Exercise 24
No. 1

Most steam turbines have more than one row of blades. There are stationary blades between each row of moving blades to re-direct the steam to get more work out of it.

QUESTIONS

These questions refer to the diagram of the simple impulse turbine. Put a circle around the letter in front of the correct answer.

1. Which way will the turbine wheel rotate?

   A. Clockwise
   B. Counterclockwise
   C. Impossible to tell

2. At which point is the steam pressure the greatest?

   A. At A
   B. At B
   C. At C

3. At which point is the steam velocity the greatest?

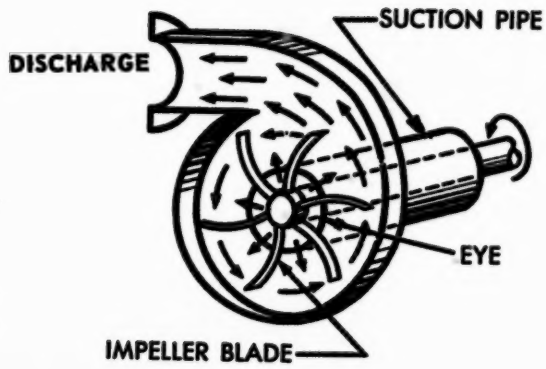
   A. At A
   B. At B
   C. At C

4. Steam comes out of

   A. an airtight case.
   B. four blades.
   C. four nozzles.
   D. a hollow shaft.

Exercise 24
Part 2

CENTRIFUGAL PUMP



Centrifugal force makes this pump work. Centrifugal force is what throws you to one side when the automobile you are riding in turns sharply.

Liquid enters the eye of the pump through the suction pipe. The suction pipe is shown at the right of the picture. The arrow shows the shaft rotating counterclockwise. The impeller wheel turns counterclockwise, also.

The rotation of the impeller wheel does two things. Centrifugal force drives the liquid outward from the center. This causes greater pressure at the outer edge of the chamber than at the eye. The blades also push the liquid around and around, making it move faster as it moves outward. The arrows show the direction of flow of the liquid.

The impeller blades of most centrifugal pumps are curved. Notice that the curve is away from the direction of rotation.

Exercise 24
Part 2

One of the uses for centrifugal pumps is in the water cooling system of automobiles.

QUESTIONS

These questions refer to the diagram of the centrifugal pump. Put a circle around the letter in front of the correct answer.

1. Water enters the centrifugal pump through the

   A. discharge.
   B. impeller.
   C. eye.
   D. shaft.

2. Which way does the impeller wheel turn?

   A. Clockwise
   B. Counterclockwise
   C. There is no way of knowing.

3. In which part of the centrifugal pump is the pressure the greatest?

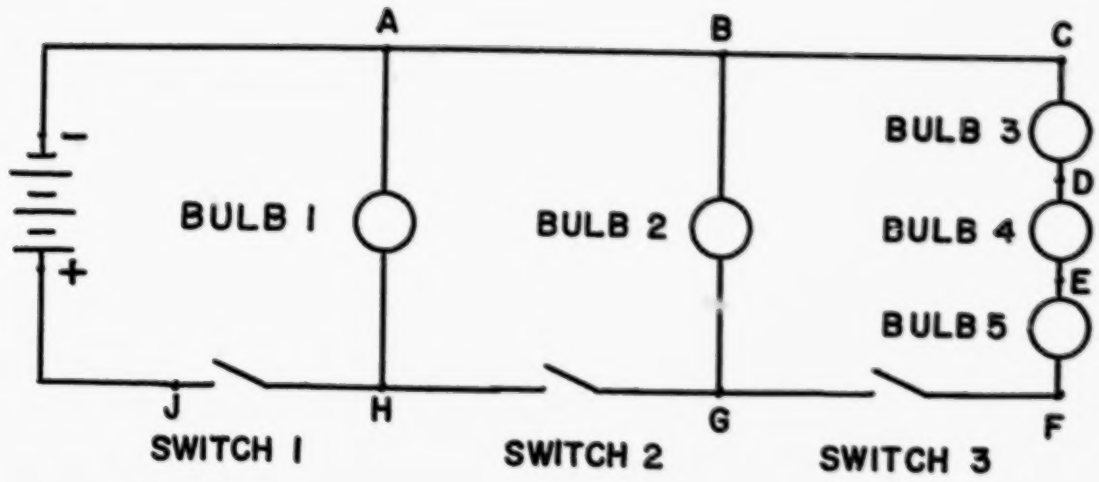
   A. The discharge pipe
   B. The eye
   C. The suction pipe
   D. The shaft

4. Which way are the blades of the impeller bent?

   A. Toward the direction of rotation
   B. Away from the direction of rotation
   C. Neither toward nor away from the direction of rotation

Exercise 24
Part 3

PARALLEL CIRCUIT



In electrical circuits two fixtures are in parallel when they share the same power supply and current runs to them independently. Most circuits in your house, school, and shop are parallel circuits.

The diagram shows a simple parallel electric circuit. The circuit runs from one side of the battery to the line containing points A, B, and C. The other side of the battery is connected to the line containing points J, H, G, and F, as well as switch 1.

Bulb 1 is connected between points A and H. Bulb 2 is connected between points B and G. Bulbs 3, 4, and 5 are connected between points C and F. Bulb 1 is parallel to bulb 2 and to the combination of bulbs 3, 4, and 5. If bulb 1 is unscrewed, bulb 2 and bulbs 3, 4, and 5 will continue to burn if all switches are closed. If bulb 2 is unscrewed, bulb 1 and the combination of bulbs 3, 4, and 5 will continue to burn. But if any one of the three bulbs (3, 4, or 5) is unscrewed, all three of them will go out, but bulbs 1 and 2 will continue to burn.

Exercise 24
Part 3

Switch 1 serves to disconnect the battery from all of the branches of the parallel circuit. In most circuits this is a double pole switch which disconnects both sides of the battery.

QUESTIONS

These questions refer to the diagram of the parallel circuit. Put a circle around the letter in front of the correct answer.

NOTE: Lights in series share the voltage. It is assumed in these questions that the voltage is such that none of the bulbs will burn out.

1. As the diagram is drawn, what must be done to make bulb 1 burn?

   A. Close switch 1
   B. Close switch 2
   C. Close switch 3
   D. It will burn without closing any switches.

2. With all three switches closed and bulb 4 removed,

   A. only bulb 1 will burn.
   B. only bulbs 1 and 2 will burn.
   C. bulbs 1, 2, and 3 will burn.
   D. bulbs 1, 2, and 5 will burn.

3. If points D and G are connected directly by a wire, and switches 1 and 2 are closed,

   A. only bulbs 1 and 2 will burn.
   B. only bulbs 1, 2, and 3 will burn.
   C. only bulb 3 will burn.
   D. all bulbs will burn.

4. If point D is connected to the positive terminal (+) and all switches are open,

   A. only one bulb will burn.
   B. only two bulbs will burn.
   C. only three bulbs will burn.
   D. all bulbs will burn.

5. Between which of these points must a wire be run to make bulbs 3, 4, and 5 burn, if switch 1 is closed?

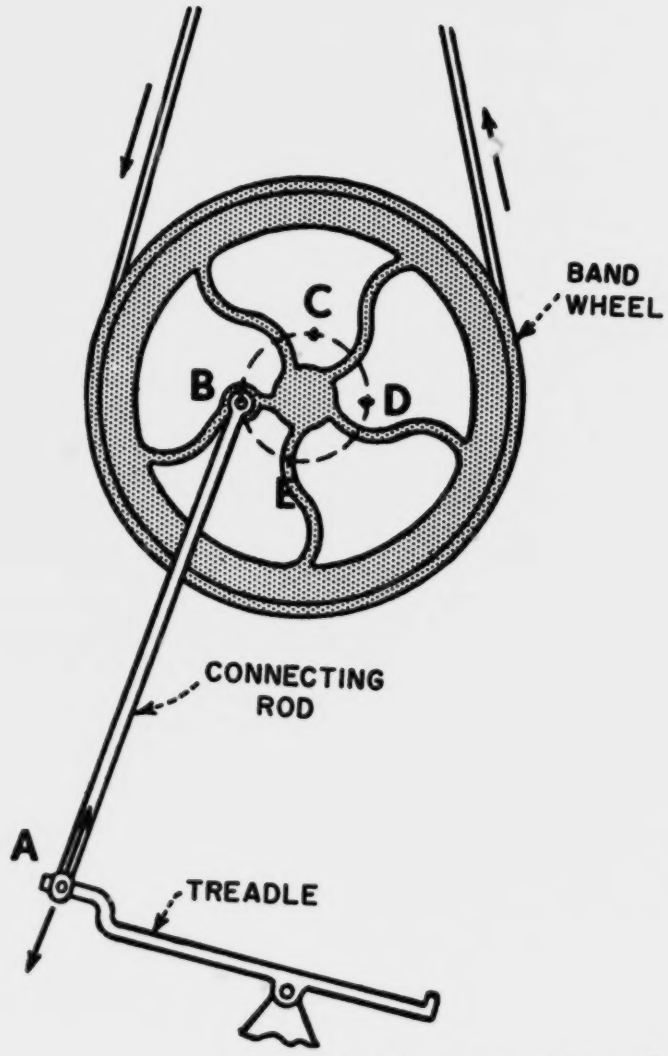
   A. A to F
   B. C to H
   C. F to H
   D. G to H

6. If all the switches are closed and bulb 1 is unscrewed,

   A. bulb 2 will go out.
   B. bulb 3, 4, and 5 will go out.
   C. All bulbs will go out.
   D. No bulb except bulb 1 will go out.

Exercise 24
Part 4

TREADLE AND CRANKSHAFT ACTION



Air Pilot Training, Bert A. Shields

A crankshaft is a device which changes reciprocating motion to rotary motion. This has many practical applications. The diagram shows how the reciprocal motion of a foot treadle is turned into rotary motion in an old-fashioned sewing machine.

The sewing machine operator's foot operates the treadle. The arrows at A shows which direction the end of the treadle moves.

The connecting rod is attached to the band wheel of the sewing machine at B. Point B goes around with the band wheel on the dotted line shown.

Exercise 24
Part 4

The band wheel is connected to the drive wheel by means of a belt.

There are many practical applications of the crankshaft. One of the most common is in the reciprocating engine where the up-and-down motion of the piston is changed to the rotary motion of the crankshaft.

QUESTIONS

These questions refer to the diagram of the treadle. Put a circle around the letter in front of the correct answer.

1. What kind of motion does point A have?

   A. Reciprocating motion
   B. Circular motion
   C. Undulating motion
   D. You cannot tell.

2. What kind of motion does point B have?

   A. Reciprocating motion
   B. Circular motion
   C. Undulating motion
   D. You cannot tell.

3. If point A moves downward, where will point B be?

   A. At C
   B. At D
   C. At E
   D. You cannot tell.

4. If point A moves downward and then returns to its present position, the bandwheel will have turned until the end of the connecting rod is at about

   A. point C.
   B. point D.
   C. point E.
   D. point B.

Exercise 25

GETTING THE IDEA

(Abstract Reasoning--Part 6)

Before attempting to do these new problems you should review the past exercises on abstract reasoning. Refresh your memory regarding the principles of direction, size, relative motion, and the addition and subtraction of parts.

Always remember that each problem may use one or more principles.

Take your time and do each problem carefully. The problems in this exercise use all the principles of abstract reasoning you have learned in the three previous ones.

When your teacher tells you, turn the page and start the exercise. Circle the letter under the box which has the drawing you think is correct.

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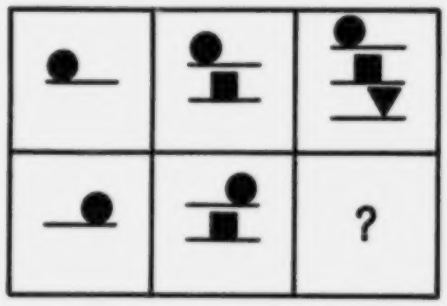

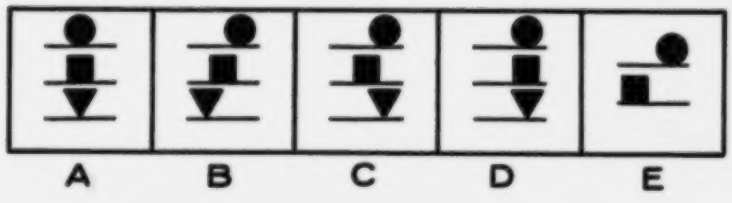

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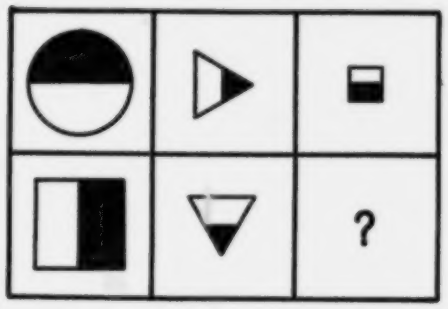

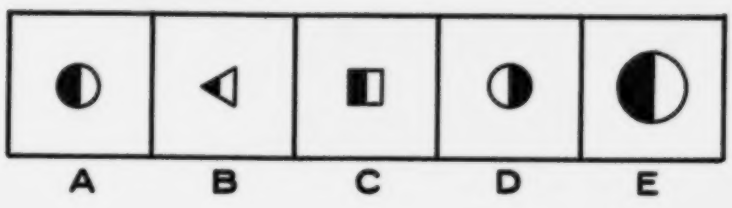

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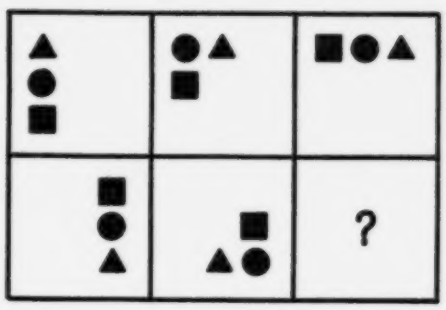

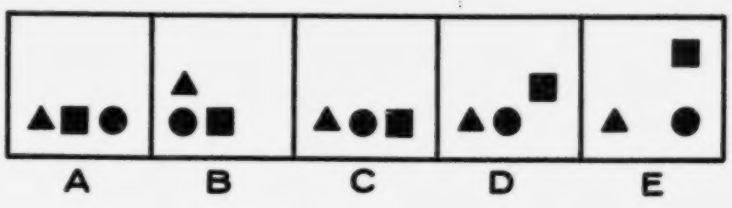

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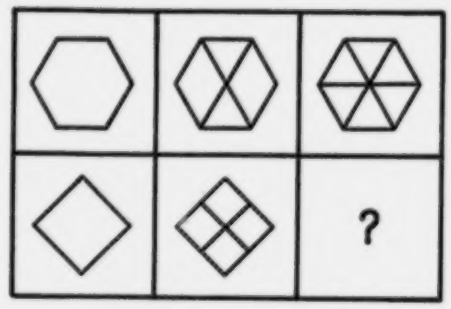

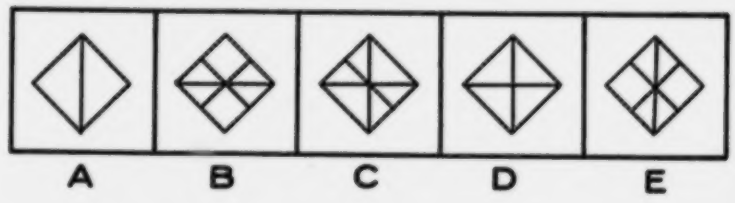

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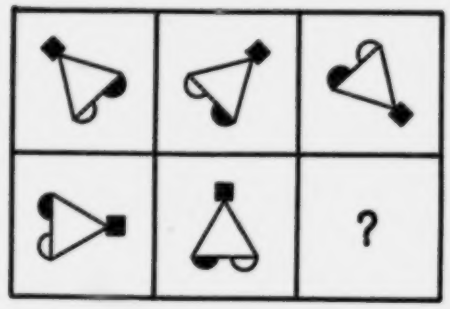

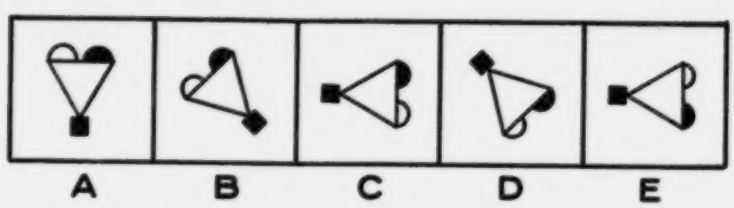

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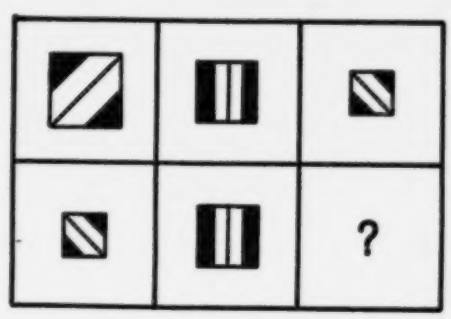

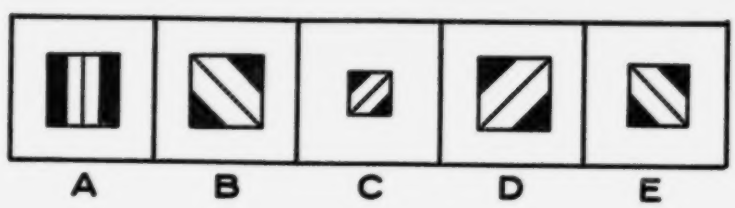

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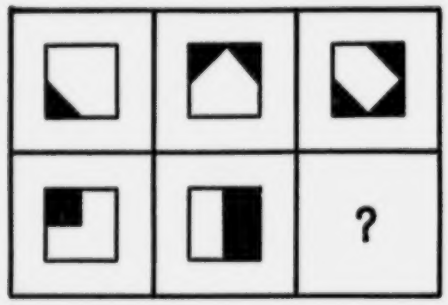

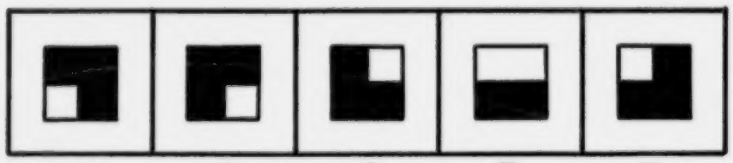

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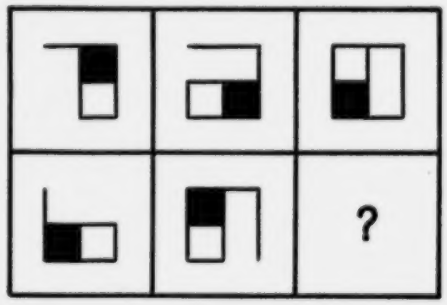

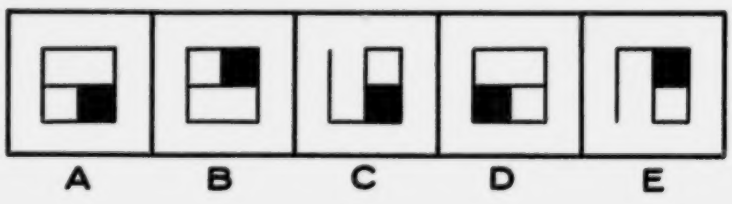

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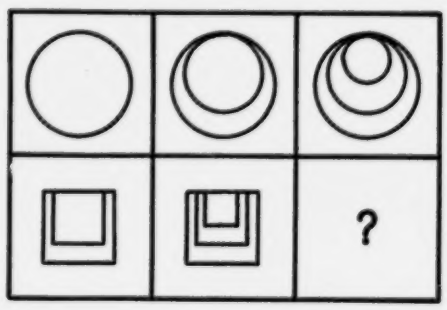

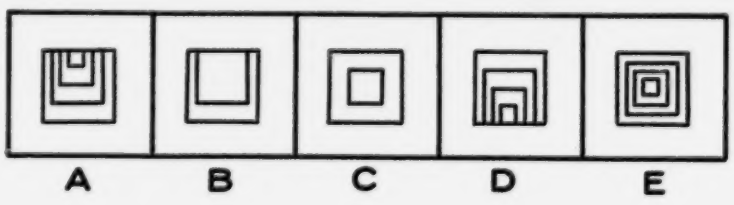

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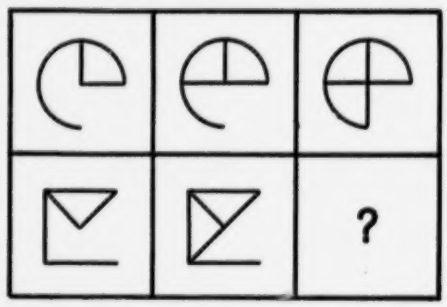

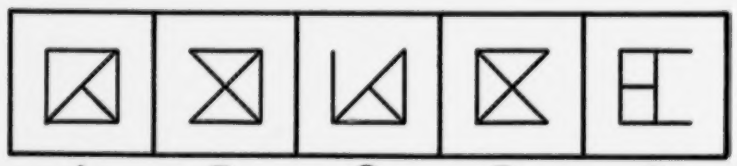

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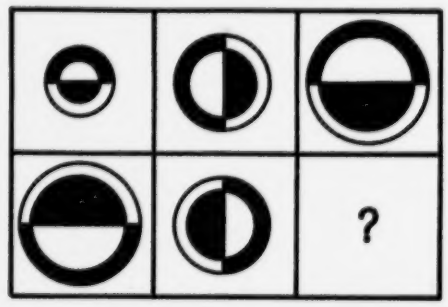

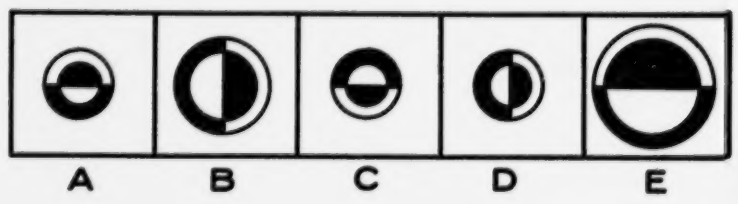

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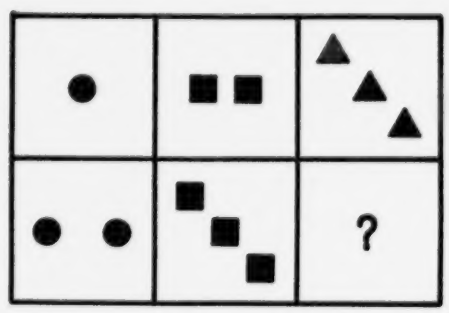

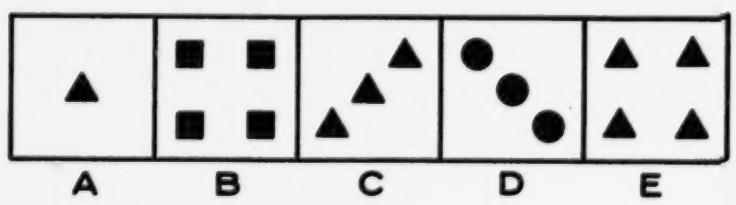

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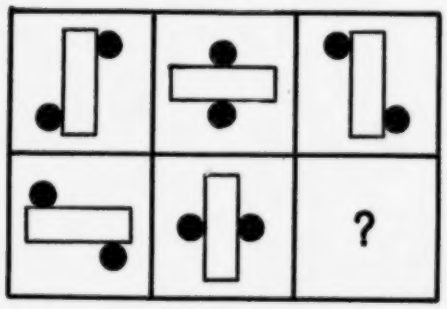

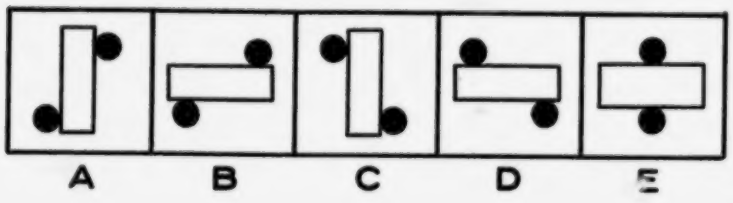

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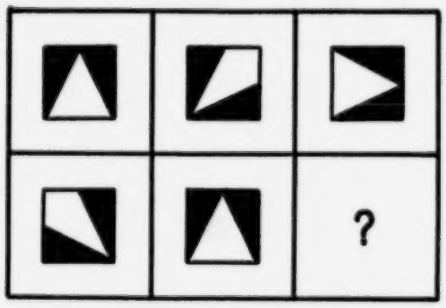

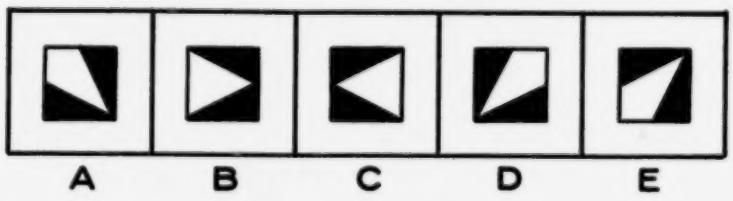

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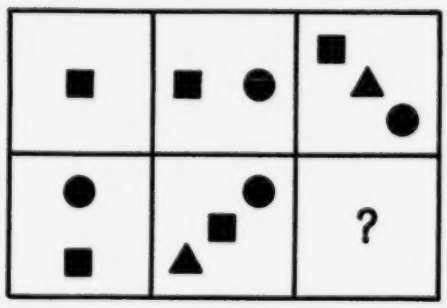
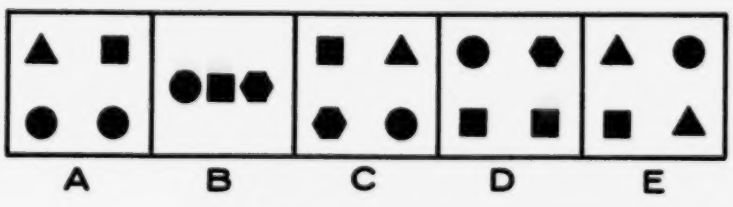
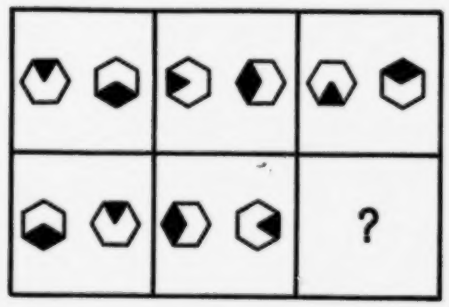
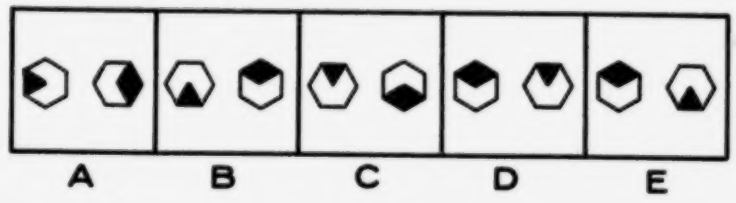


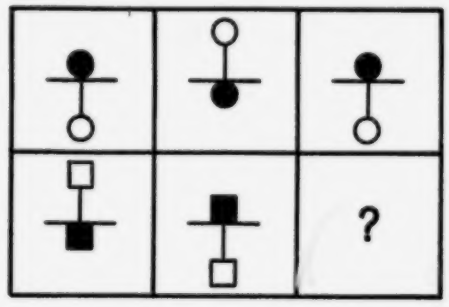


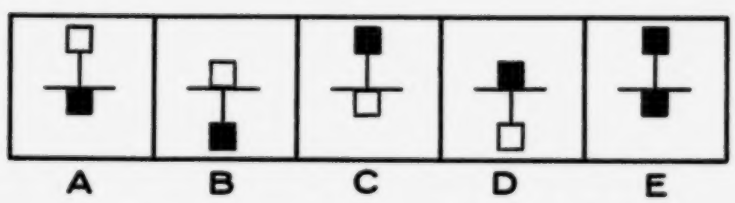
16



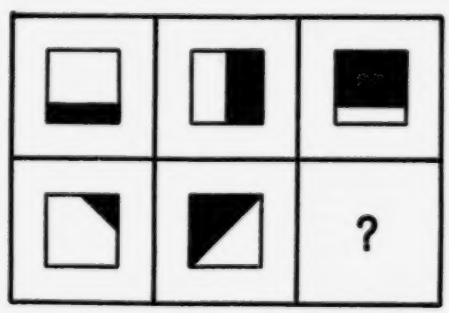


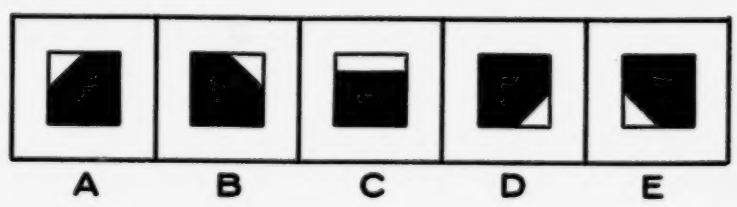
17





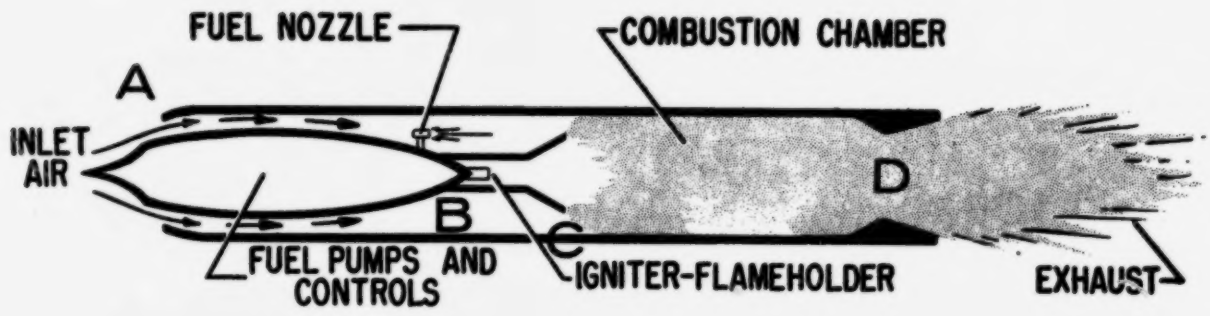
18





Exercise 26
Part 1

RAMJET ENGINE



A ramjet engine is often called a flying stovepipe. It is the simplest of all power plants that use atmospheric air to support combustion.

Air comes in the opening at the front end, and flows around the fuel pumps and control section. This passage is designed to convert the energy of the entering air into static pressure. This part of the operation is known as RAM. The high pressure air flows by the fuel nozzle which injects fuel into the air-stream. At about the highest pressure point in the engine, the igniter-flameholder ignites the mixture.

The gases of combustion and the heated air expand. They are ejected from the exit nozzle at a much higher speed than the air entering the engine. This change in speed of the entering and departing air results in the thrust.

The "Buzz Bombs" with which the Germans attacked Britain during World War II were powered by ramjets. The ramjet has been used experimentally on helicopters and in pods on fighter planes and bombers for quick thrust boosts.

Exercise 26
Part 1

QUESTIONS

These questions refer to the diagram of the ramjet engine. Put a circle around the letter in front of the correct answer.

1. Where is the fuel nozzle located?

   A. Between the air inlet and the combustion chamber
   B. Between the combustion chamber and the exhaust
   C. Between the igniter-flameholder and the exhaust
   D. Between the inlet and the fuel pump

2. At which point does the air flow fastest?

   A. A
   B. B
   C. C
   D. D

3. Combustion begins at point

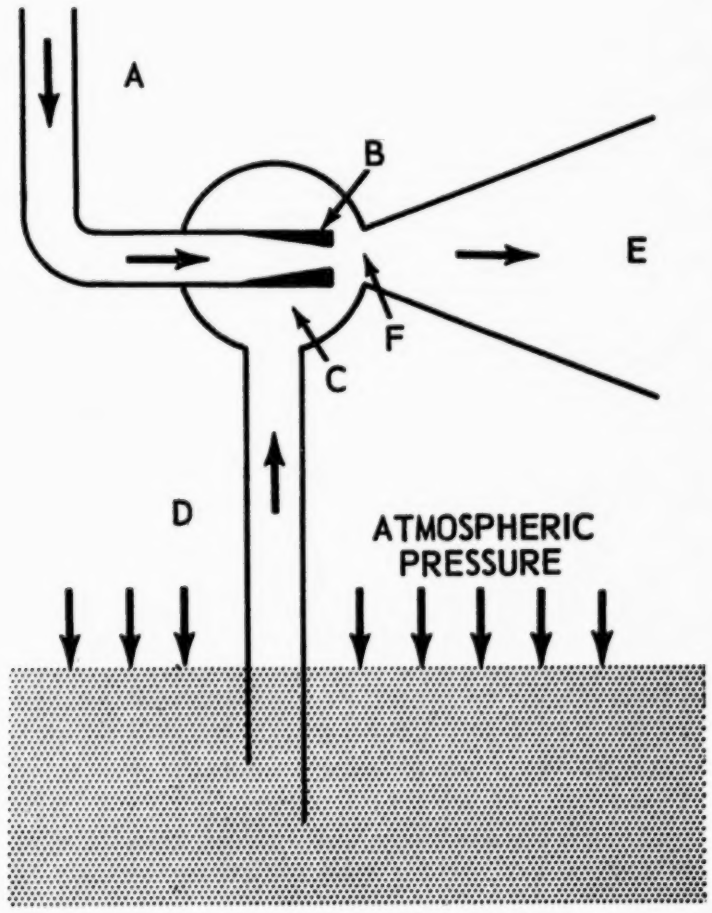
   A. A.
   B. B.
   C. C.
   D. D.

4. At what point is pressure greatest?

   A. A
   B. B
   C. C
   D. D

Exercise 26
Part 2

JET PUMP



Jet pumps have no moving parts. A jet pump which uses steam to pump air, water, or other fluids is also called an ejector.

The diagram shows a simplified jet pump. Steam under pressure comes in through pipe A. It goes through nozzle B. As the nozzle is smaller than the pipe, the speed of the steam increases. This jet of steam going through point F drives out the fluid in chamber C. Discharge line E opens out gradually beyond the chamber. This decreases the speed of the discharge.

The pressure in the chamber is lowered as the jet drives some of the liquid out. The atmospheric pressure on the surface of the liquid lifts the liquid up the pipe to equalize the pressure and refill chamber C.

Exercise 26
Part 2

A jet pump which uses water instead of steam is called an eductor.

QUESTIONS

These questions refer to the diagram of the jet pump. Put a circle around the letter in front of the correct answer.

1. At which point does the steam come into the pump?

   A. Point A
   B. Point B
   C. Point C
   D. Point F

2. What is the part of the pump at point B called?

   A. The intake
   B. The nozzle
   C. The discharge
   D. The feed pipe

3. At which point is the pressure the lowest?

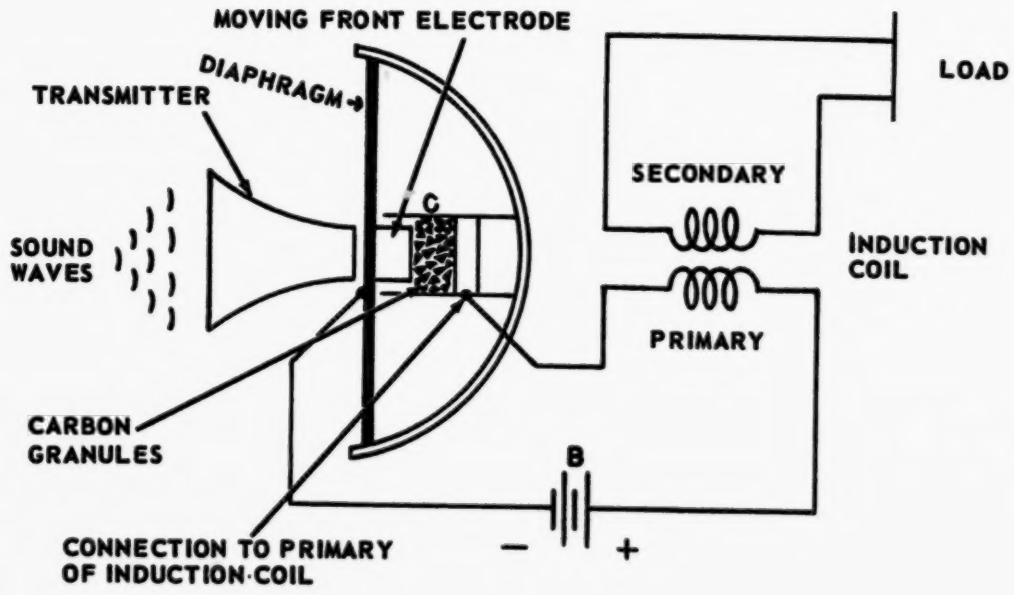
   A. Point A
   B. Point B
   C. Point C
   D. Point D

4. At which point is the pressure the greatest?

   A. Point C
   B. Point D
   C. Point E
   D. Point F

Exercise 26
Part 3

TELEPHONE TRANSMITTER



This is a wiring diagram for a telephone transmitter. The purpose of a telephone transmitter or microphone is to turn sound waves into an electrical signal. The basic parts of the circuit are the battery, the diaphragm, the carbon granules, and the induction coil.

The electrical circuit goes from the negative side of the battery to the diaphragm. The diaphragm is connected to the moving front electrode. The electrical circuit flows from the front electrode through the carbon granules to the back electrode. From there it flows through the primary winding of the induction coil back to the positive side of the battery.

The sound waves strike the diaphragm and make it vibrate. The pattern of vibrations depends upon the words being spoken. The vibrations of the diaphragm make the movable front electrode move in and out with it. This movement compresses the carbon granules when the diaphragm moves in, and releases them when it

moves out. Compressing the carbon granules decreases their resistance to the electric current. As the compression on the carbon granules decreases, the resistance to the flow of current increases.

The change of resistance varies exactly like the pattern of sound waves which strikes the diaphragm. The change of resistance varies the amount of current flowing through the electrical circuit. The induction coil serves to transfer these same current patterns, or modulations, to all the receivers in the system which are connected to the secondary winding.

QUESTIONS

1. When the carbon granules are compressed, the resistance in the circuit
   A. increases.
   B. decreases.
   C. neither increases nor decreases.

2. The diaphragm is wired directly to the
   A. negative terminal of the battery.
   B. positive terminal of the battery.
   C. load.
   D. secondary of the induction coil.

3. The carbon granules are compressed by the
   A. load.
   B. induction coil.
   C. moving front electrode.
   D. battery.

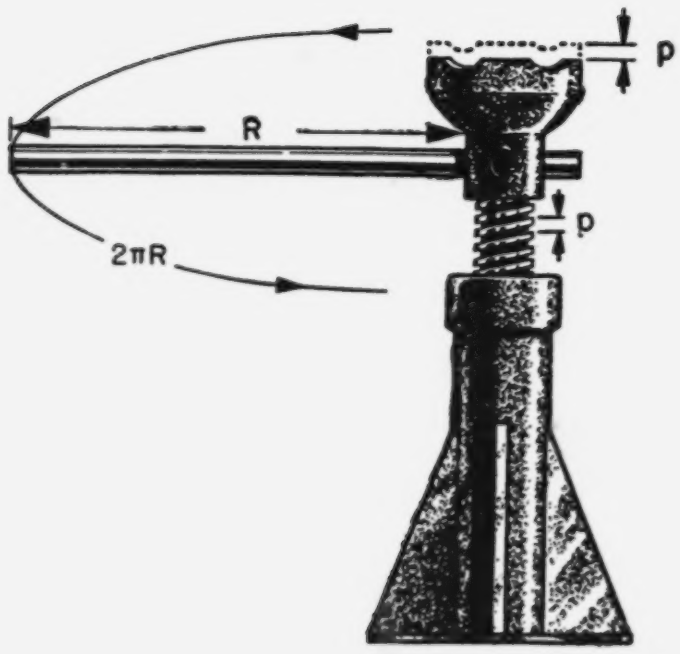
4. The diaphragm is connected directly to the
   A. moving front electrode.
   B. induction coil.
   C. insulators.
   D. the load.

5. Sound waves are turned into vibrations by means of the
   A. diaphragm.
   B. paper spacers.
   C. brass grid.
   D. carbon chamber.

6. Which of the following is not in the primary circuit?
   A. The carbon granules
   B. The battery
   C. The secondary coil
   D. The moving front electrode

Exercise 26
Part 4

JACK



This is the type of jack used to raise houses and other very heavy weights. Sometimes it is called a jack screw. If you pull the lever handle around one turn, its outer end describes a complete circle. The distance the end of the handle moves through is about three times the diameter of the circle. This is also about six times the length of the handle.

For each complete turn of the handle, the screw thread lifts the top of the jack the distance equal to one thread. This is called the pitch of the screw, and is marked "p" on the drawing.

You can see that the power of the jack is very great. If the handle is two feet long, then the end of the handle moves through a distance of about twelve feet on each turn. If the pitch of the threads is one-fourth of an inch, then the weight is lifted the amount of the pitch on each turn of the handle. This means that the end of the handle would move through

about 48 feet to lift a weight one inch. Therefore it would have to move through 12 times 48 feet to lift a weight one foot. This is about 576 feet.

This means that this jack with a 2-foot handle and a $\frac{1}{4}$-inch pitch has a power factor (disregarding friction) of about 600 to 1.

QUESTIONS

The following questions refer to the drawing of a jack. Mark your answer to each question by drawing a circle around the correct response.

NOTE: In answering these questions, disregard <u>friction</u>.

1. When the handle is turned one complete turn, how much does the top of the jack move?

   A. The distance R
   B. The distance $2\pi R$
   C. The distance p
   D. The distance 2 times p

2. The distance p is known as

   A. the diameter.
   B. the circumference.
   C. the pitch diameter.
   D. the pitch.

3. The power factor of this jack is about

   A. 600 to 1.
   B. 400 to 1.
   C. 200 to 1.
   D. You cannot tell.

4. If the handle of the jack were three feet long, what would be the power factor of the jack?

   A. 900 to 1
   B. 600 to 1
   C. 400 to 1
   D. You cannot tell.

5. How many times does the handle turn to raise the top of the jack one inch?

   A. 5 times
   B. 4 times
   C. 3 times
   D. 2 times

6. What is the ratio of the speed of the top of the jack to the end of the handle?

   A. 1 to 200
   B. 1 to 400
   C. 1 to 600
   D. 1 to 900

Exercise 27

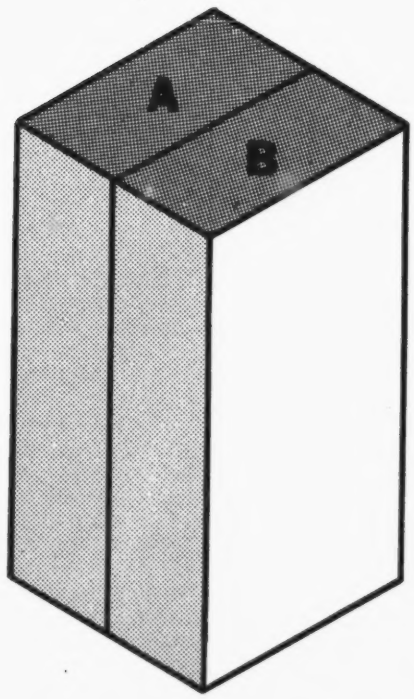
SEEING THINGS IN THREE DIMENSIONS

(Brick Counting--Part 1)

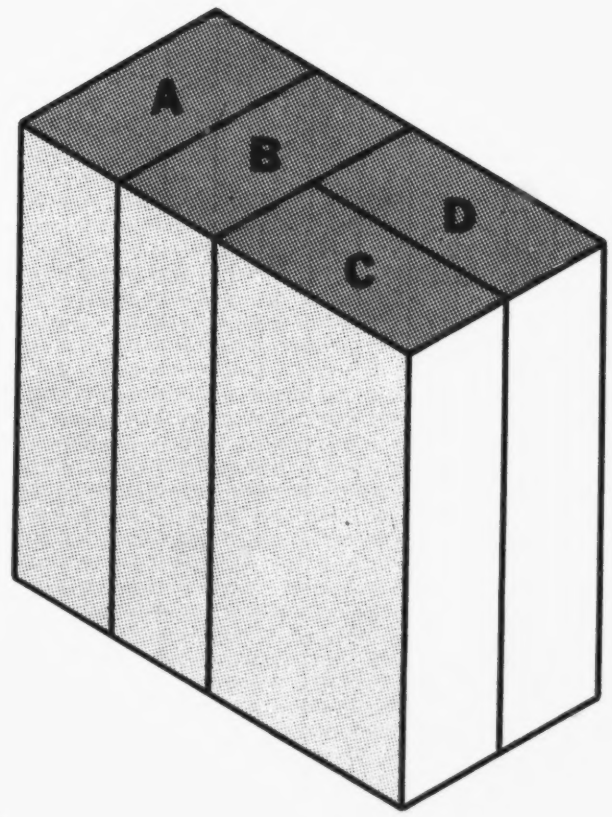
Like exercise 18 of Part C, the idea is to count the number of bricks in each drawing. It is important for you to remember that all the bricks used in this exercise are the same size.

Example 1 shows two bricks (A and B). Both bricks are identical--that is, bricks A and B have the same height, width, and thickness. Example 2 has 4 bricks. Bricks C and D touch brick B. The long side of the top of brick B is twice as long as the short side of the tops of bricks C and D.

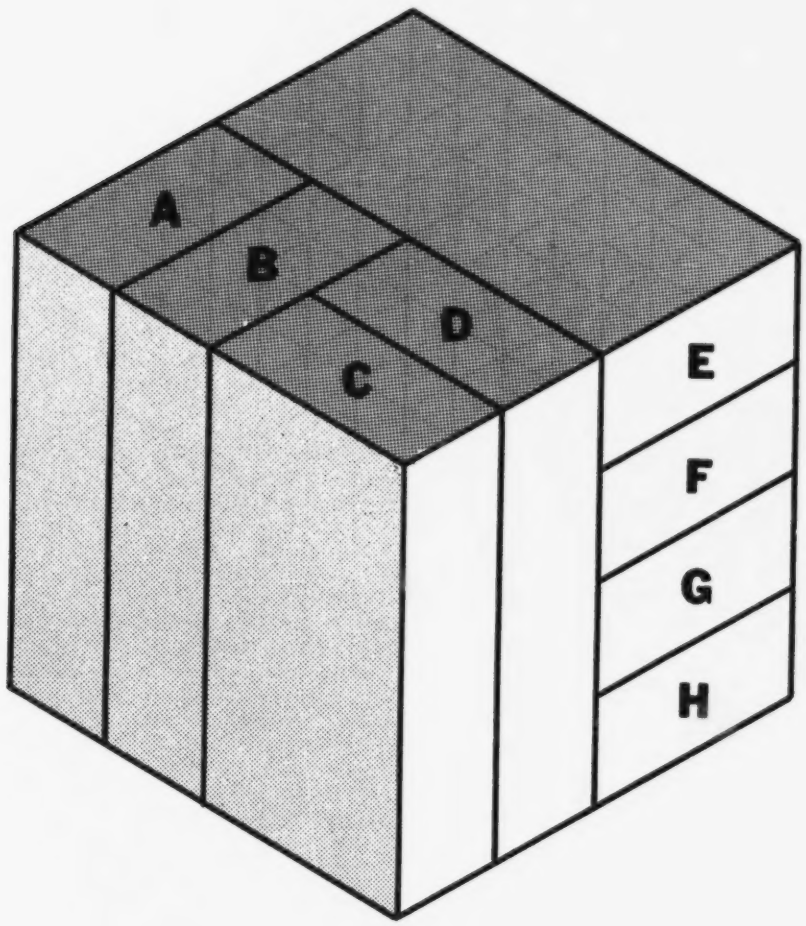
EXAMPLE 1



EXAMPLE 2



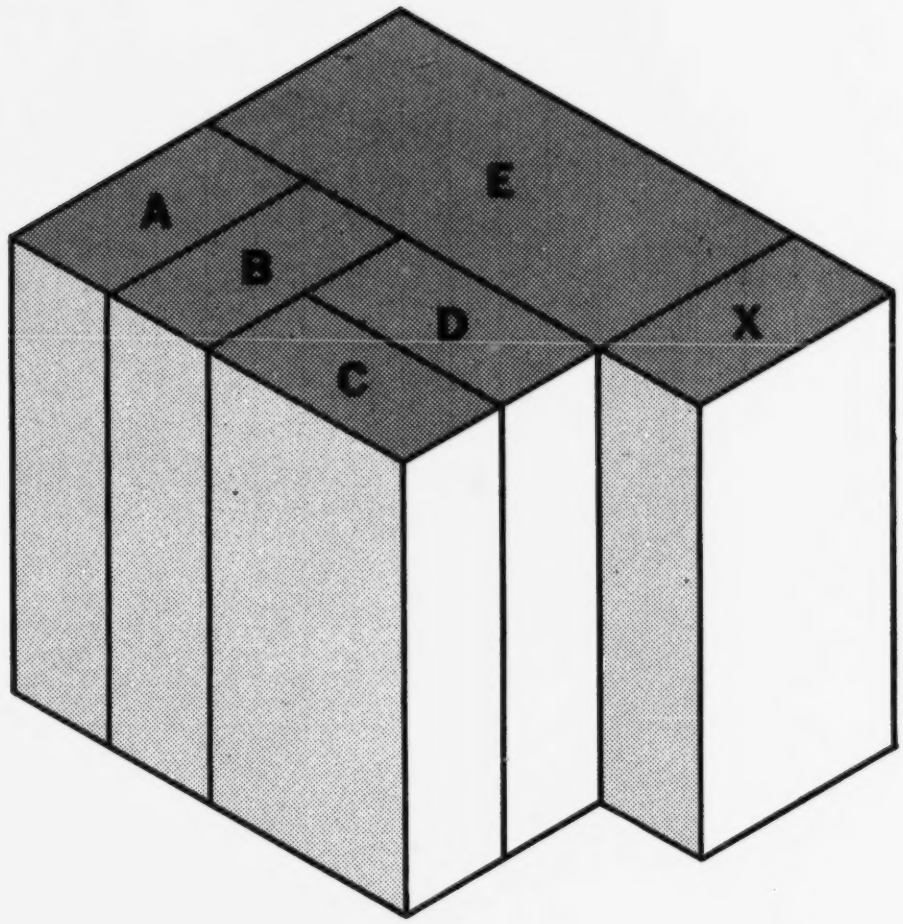
How many bricks can you count in the next example?



Example 3 is a picture of 8 bricks. Bricks E, F, G, and H touch bricks A, B, and D. The important rule to remember in this example is that each brick is four times as tall as it is thick.

So far all the bricks in the pictures have been visible. In other words, no bricks have been hidden from sight. Look at the example on the next page and count the number of bricks.

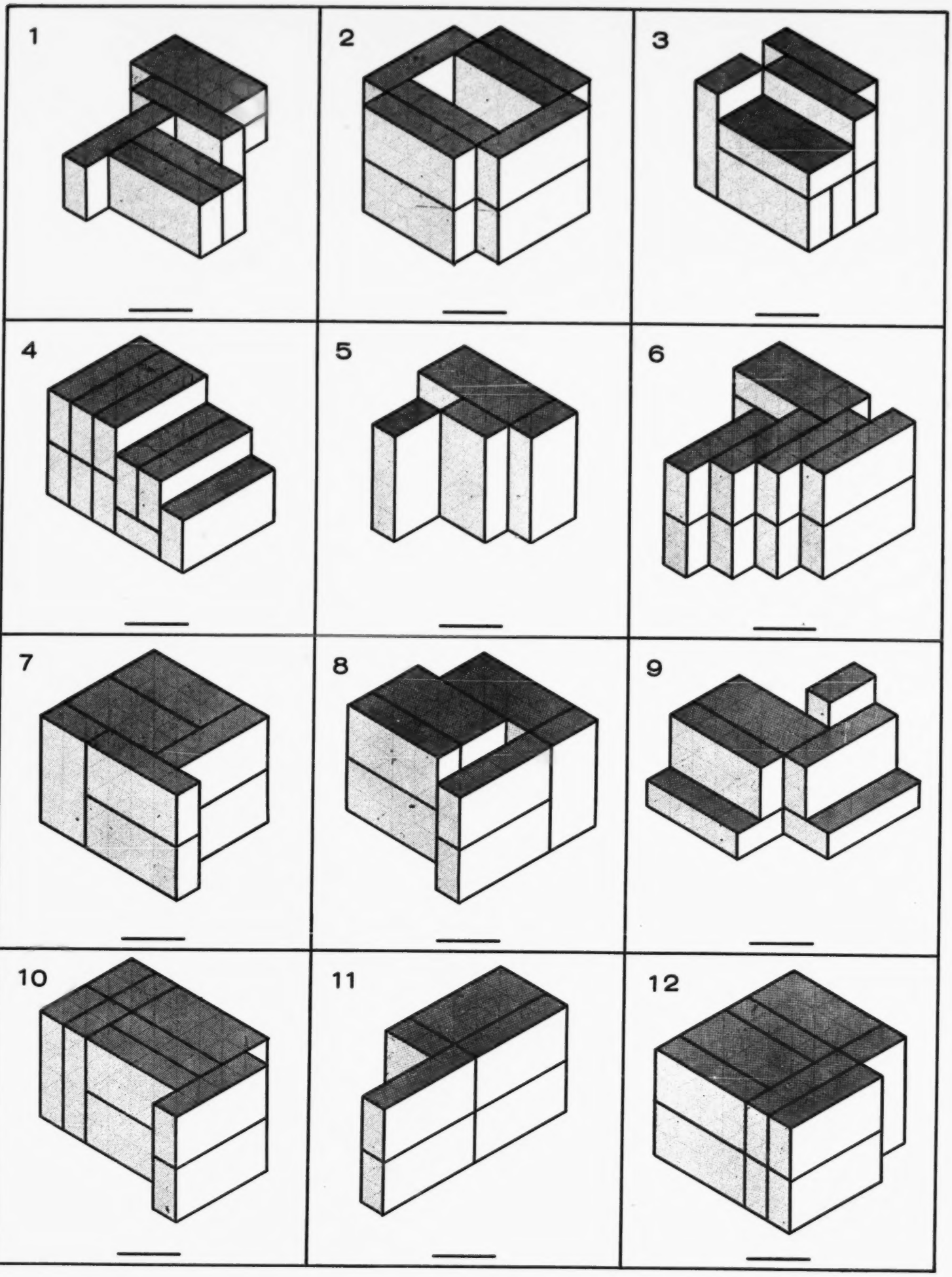
EXAMPLE 4



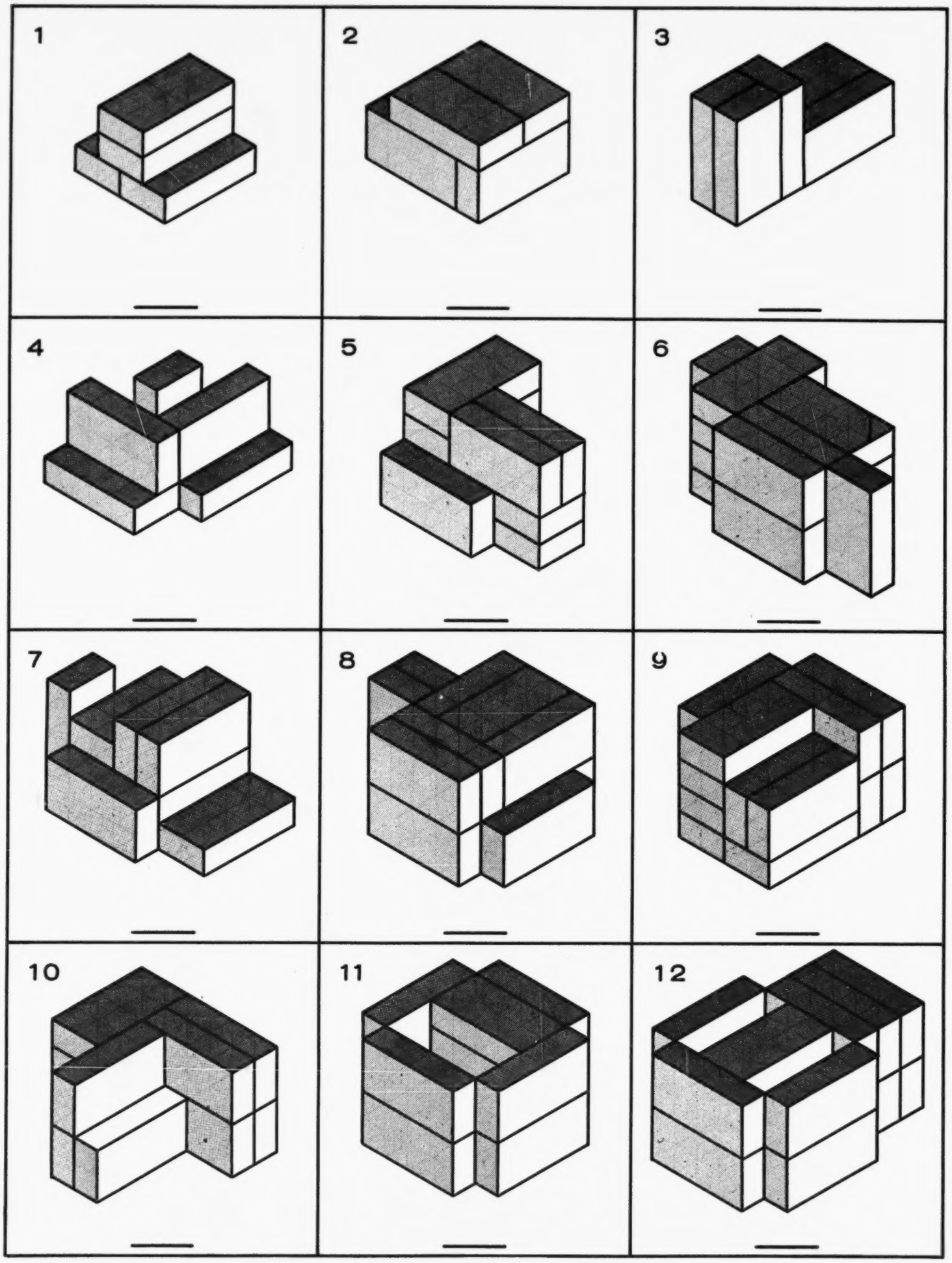
You can see six bricks (A, B, C, D, E, and X), but you know that there are three more bricks under brick E (look at example 3). The ends of these three bricks cannot be seen because brick X is in the way. The answer is 9 bricks.

Directly under each problem there is a line. Put your answer on this line.

Drill 1



Drill 2



Exercise 27

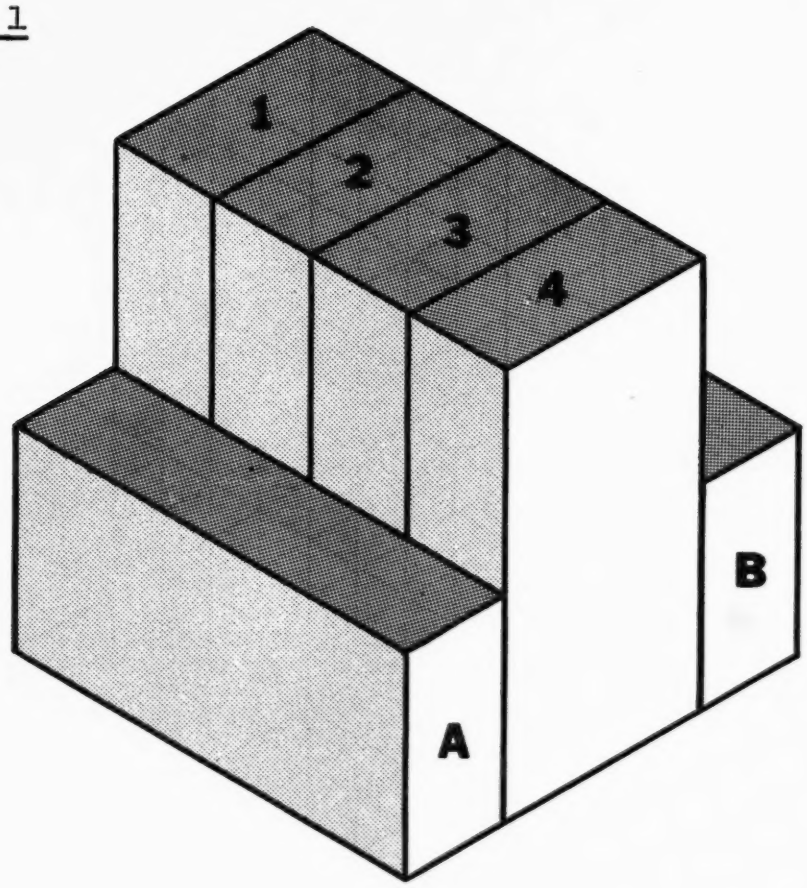
SEEING THINGS IN THREE DIMENSIONS

(Brick Counting--Part 2)

The rules concerning the size of the bricks are the same in this exercise as in Part 1. The idea is to count the number of bricks touching each lettered brick.

In the example below, how many bricks are touching brick A?___ How many are touching brick B?___

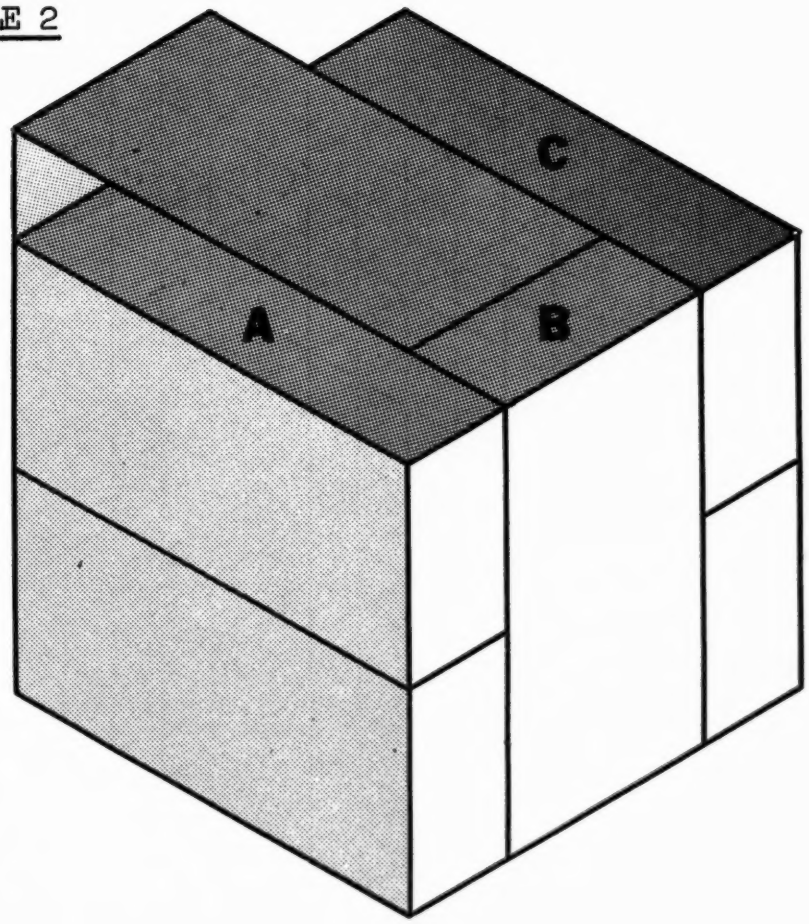
EXAMPLE 1



Bricks 1, 2, 3, and 4 are touching brick A. These same four bricks touch brick B; therefore, the answer is 4 to both questions.

The next example is exactly like the problems you will have to solve in this exercise. Find how many bricks are touching brick A and then brick B, and finally brick C. Put your answer to each question on the line to the right of each corresponding letter.

EXAMPLE 2



A____

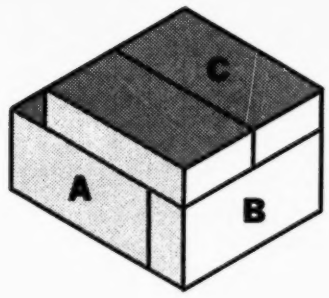
B____

C____

Brick A is touching 4 bricks. It is on top of one brick and it also touches brick B and two bricks behind B. Brick B touches 8 bricks. There are four bricks behind B and two on each side. B touches all of these bricks. Brick C is placed in the same way as brick A. It touches 4 bricks in the same way as A.

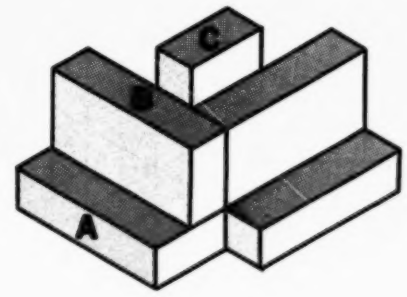
Drill 1

1



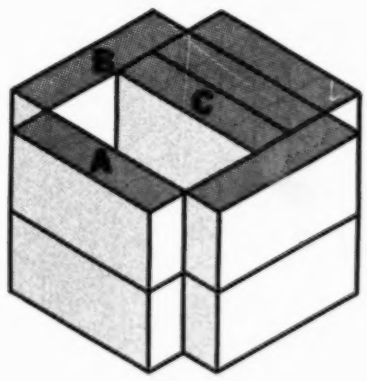
A___ B___ C___

2



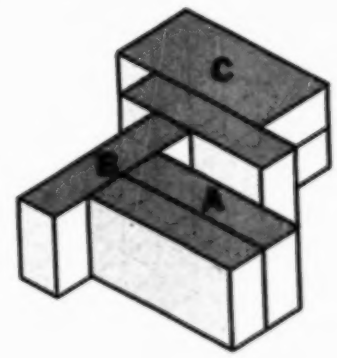
A___ B___ C___

3



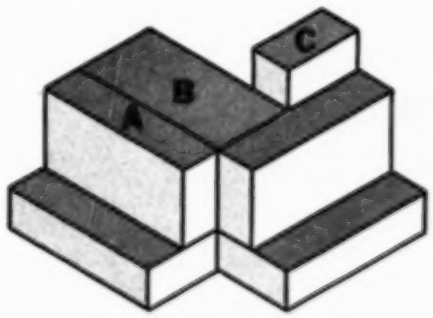
A___ B___ C___

4



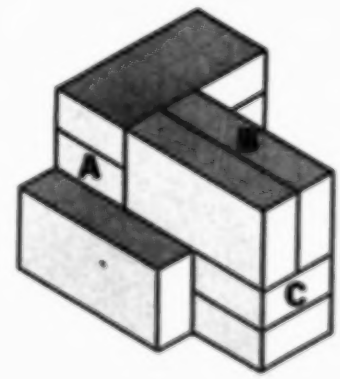
A___ B___ C___

5



A___ B___ C___

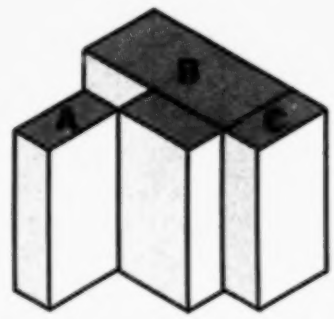
6



A___ B___ C___

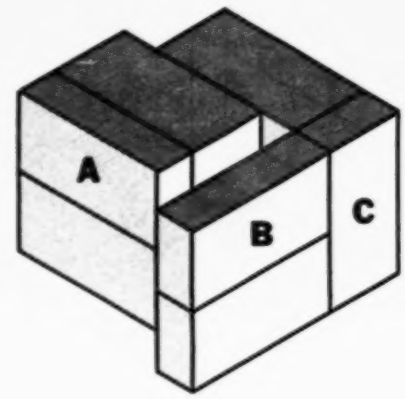
Drill 2

1



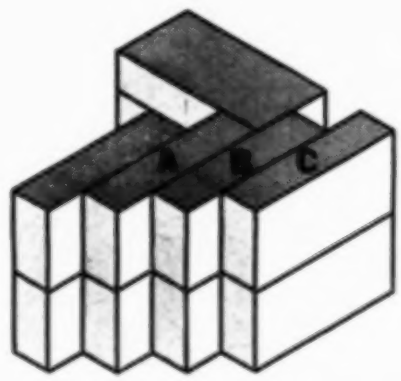
A___ B___ C___

2



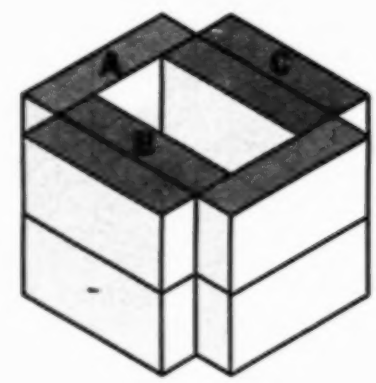
A___ B___ C___

3



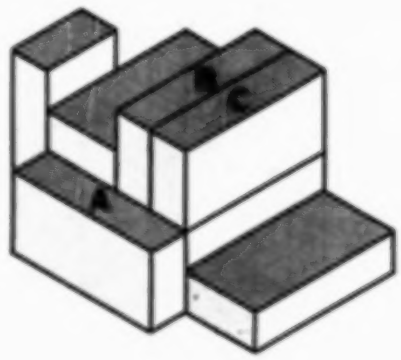
A___ B___ C___

4



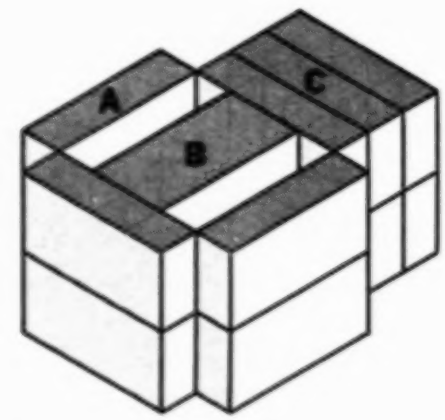
A___ B___ C___

5



A___ B___ C___

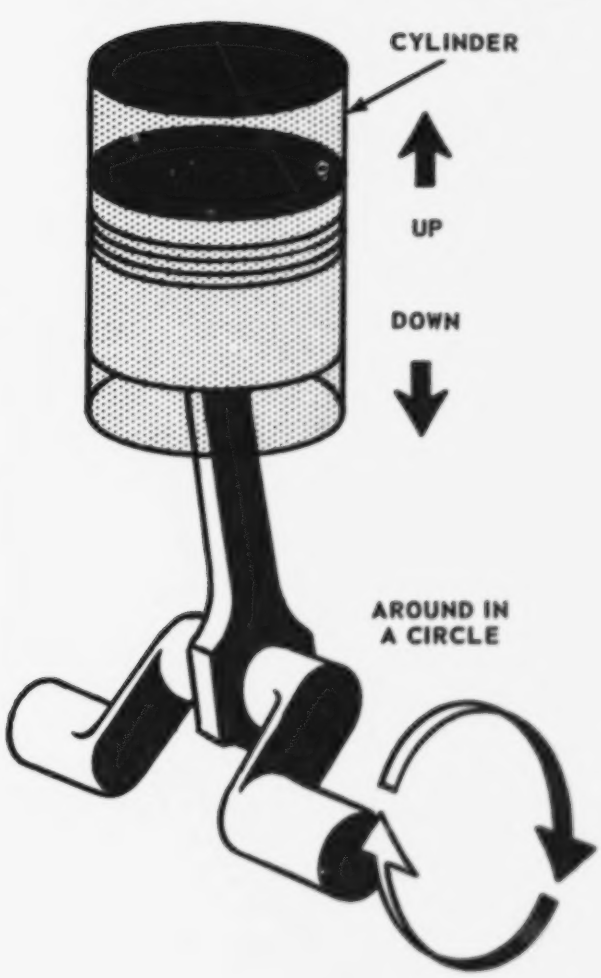
6

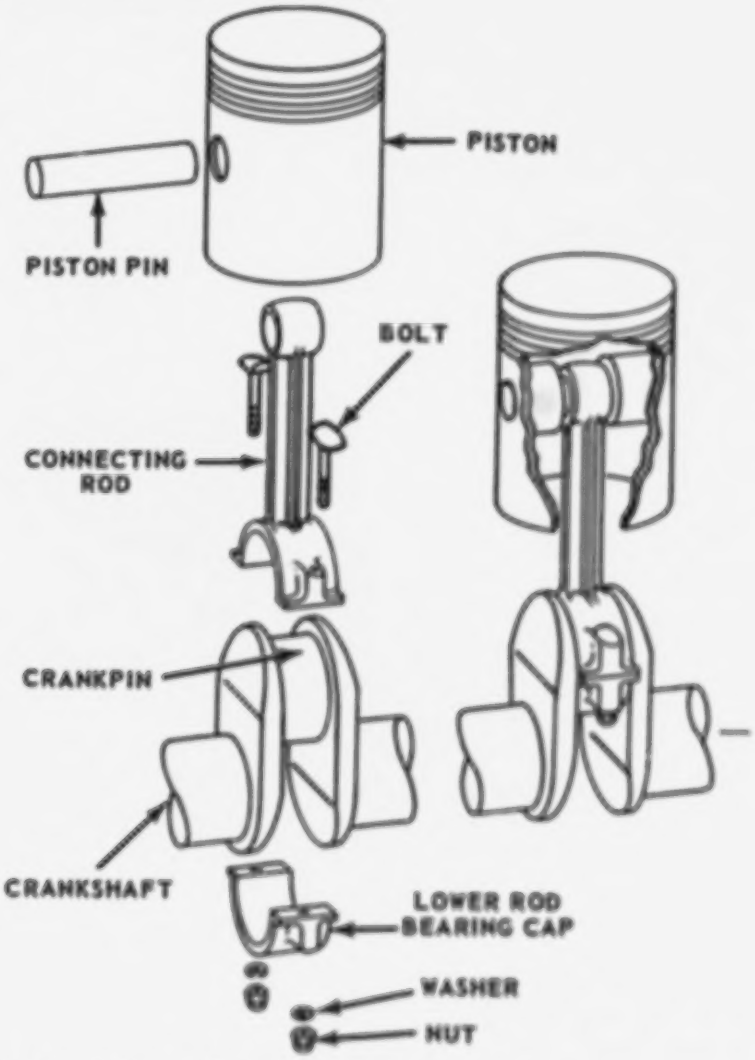


A___ B___ C___

Exercise 28
Part 1

PISTON, CONNECTING ROD, AND CRANKSHAFT





The connecting rod of an internal combustion engine is necessary to its operation. It changes the up-and-down motion of the piston into the circular motion of the crankshaft.

The drawing on the right shows the essential parts of a connecting rod. It is attached to the piston by means of a piston pin. It is connected to a crankpin of the crankshaft by means of a bearing cap. The drawing shows two bolts, two washers, and two nuts holding the lower rod bearing cap in place. The drawing also shows an "exploded" view of the assembly and an assembled view. The assembled view shows a section of the piston wall cut away to show the upper end of the connecting rod.

Exercise 28
Part 1

The crankpin moves around in a circle. The size of this circle controls the distance the piston moves up and down within the cylinder.

If there are four cylinders in the engine, then there will be four crankpins. If there are eight cylinders, then there will be eight crankpins.

QUESTIONS

These questions refer to the diagram of the piston, connecting rod, and crankshaft. Put a circle around the letter in front of the correct answer.

1. Which of the following do not go around in a circle?

   A. Bolts
   B. Lower rod bearing cap
   C. Crankpin
   D. Piston pin

2. Which of the following does not go up and down?

   A. Cylinder
   B. Piston
   C. Piston pin
   D. Connecting rod

3. Which part is held on by bolts and nuts?

   A. Piston pin
   B. Lower rod bearing cap
   C. Crankpin
   D. Piston

4. Where is the crankpin when the piston is up in the cylinder?

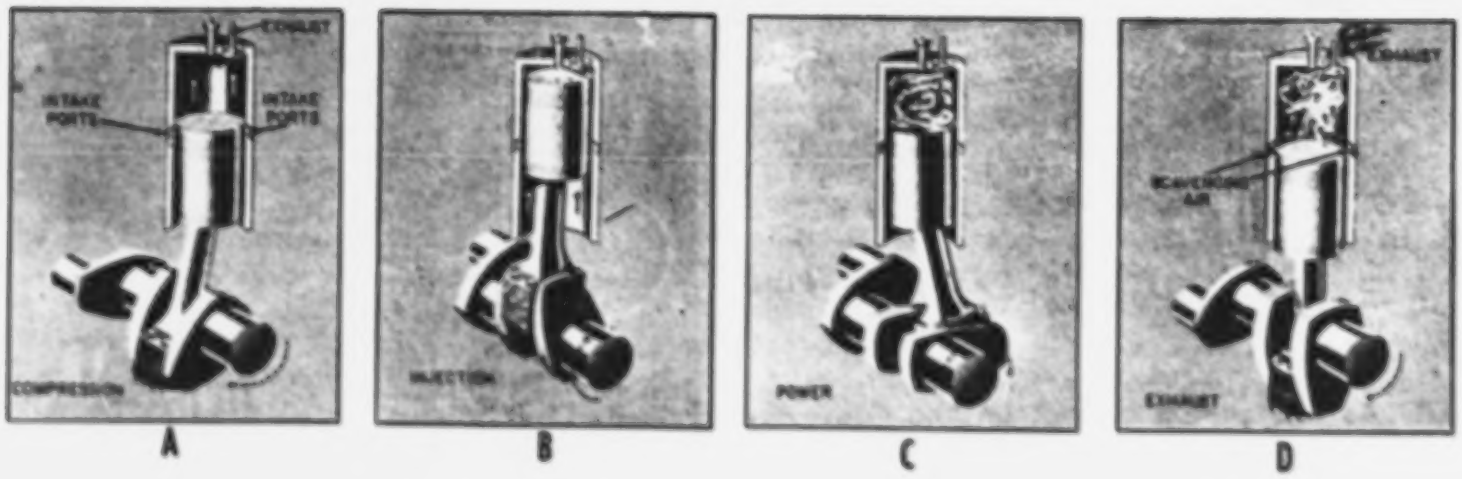
   A. Up all the way
   B. Down all the way
   C. Half way down
   D. You cannot tell.

5. If the engine has six cylinders, how many crankpins are there?

   A. 2
   B. 4
   C. 6
   D. 8

Exercise 28
Part 2

TWO-STROKE-CYCLE DIESEL ENGINE



The diagrams show the operation of the two-stroke-cycle diesel engine. The cylinder has an exhaust valve but no intake valve. The air enters the combustion chamber through ports (openings) in the cylinder wall. These ports are uncovered by the piston as it nears the bottom of each stroke.

In diagram A the piston is moving upward on the compression stroke. The exhaust valve and the intake ports are closed. The piston is compressing the air in the combustion chamber.

The top of the stroke is shown in diagram B. When the piston is in this position, fuel is sprayed into the cylinder. It ignites immediately because the air in the cylinder has been compressed so much that it is very hot.

Diagram C shows the piston moving down on the power stroke as the fuel and air burn and expand. The exhaust valve is still shown closed. The pressure on the piston pushes the connecting rod and drives the crankshaft.

Exercise 28
Part 2

As the piston nears the bottom of the power stroke, shown in diagram D, it uncovers the intake ports. Air comes in from a blower (air pump) through the intake ports, pushing the burned gases out the exhaust valve. The scavenging (removing exhaust gases) operation takes place until the piston starts back up, covering the intake ports. At the same time, the exhaust valve closes and the cycle starts again.

QUESTIONS

The questions below refer to the diagram of the two-stroke-cycle diesel engine. Put a circle around the letter in front of the correct answer.

1. How many times does the piston move up on one complete cycle of this engine?

   A. Once
   B. Twice
   C. Three times
   D. Four times

2. In which operation does scavenging (removing exhaust gases) take place?

   A. Compression
   B. Injection
   C. Power
   D. Exhaust

3. In which operation does the fuel enter the cylinder?

   A. Compression
   B. Injection
   C. Power
   D. Exhaust

4. In which direction is the crankshaft rotating in this engine?

   A. Clockwise
   B. Counterclockwise
   C. You can't tell.

5. What ignites the fuel in this engine?

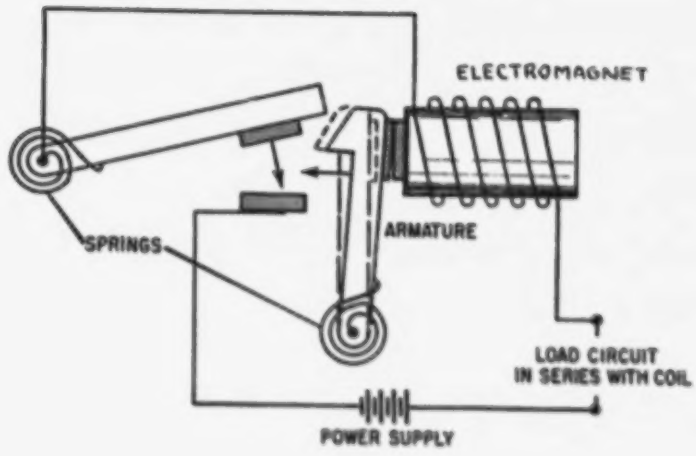
   A. A spark plug
   B. An igniter
   C. Hot air
   D. It does not ignite.

6. What causes air to enter the cylinder?

   A. The motion of the piston
   B. The motion of the cylinder
   C. A blower
   D. A scavenger

Exercise 28
Part 3

MAGNETIC CIRCUIT BREAKER



The essential parts of a magnetic circuit breaker are an electromagnet, armature, breaker points, and springs.

Circuit breakers are used in many ways. One of its most frequent uses is to break an electrical circuit if the load gets too high. Heavy loads, or high currents, are liable to burn out equipment, or to cause shorts which might cause an electrical fire.

In the circuit breaker shown in the diagram, the current flows continuously through the coil of wire around the electromagnet. When there is no current being used, then the electromagnet does not pull the armature. That position is shown by dashes in the drawing. The spring attached to the pivot of the armature keeps the armature away from the electromagnet. When the armature is away from the electromagnet, the shoulder of the armature keeps the contact bar down. This keeps the two breaker points together.

When the current in the circuit makes the pull of the electromagnet stronger than the armature spring, then it pulls the armature toward it. This releases the contact bar. The contact bar spring makes the two breaker points separate, breaking the circuit.

Exercise 28
Part 3

The amount of current needed to operate the electromagnet is controlled by changing the strength of the armature spring.

QUESTIONS

These questions refer to the diagram of the magnetic circuit breaker. Put a circle around the letter in front of the correct answer.

1. What is the normal position of the armature?

   A. It is shown by the solid lines.
   B. It is shown by the dashed lines.
   C. It is not shown.

2. What causes the armature to move when there is an overload?

   A. Contact bar spring
   B. Armature spring
   C. Electromagnet
   D. Contacts

3. Which of the following does the current NOT go through?

   A. Electromagnet
   B. Contacts
   C. Contact bar
   D. Armature

4. What kind of a circuit is used in the magnetic circuit breaker?

   A. Series circuit
   B. Parallel circuit
   C. Series-parallel circuit
   D. None of the above

5. Which of the following does the shoulder of the armature hold down?

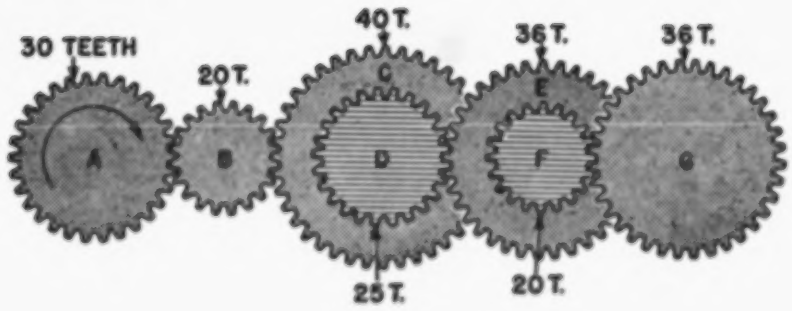
   A. Armature spring
   B. Electromagnet
   C. Contact bar
   D. Lower contact

6. Which direction does the armature spring make the armature move?

   A. Right
   B. Left

Exercise 28
Part 4

GEAR TRAIN



The gear train shown has seven spur gears mounted on five shafts. Gears A, C, D, and G turn clockwise. Gears B, E, and F turn counterclockwise.

Gears C and D are mounted on the same shaft, and turn in the same direction and at the same speed. Gears E and F are also mounted on the same shaft and turn in the same direction and at the same speed.

Gear B is an idler gear. This means that it does not increase or decrease the speed or power of the gear train. Gears A and C would turn in opposite directions if they were meshed directly. Now they turn in the same direction.

You will note that in each pair of successive meshing gears, the gear with the larger number of teeth is on the right. Gear C has more teeth than A; gear E has more teeth than D; and gear G has more teeth than F. This means that gear G will move much slower than gear A. It also means that gear G will have much more power than gear A.

Exercise 28
Part 4

QUESTIONS

These questions refer to the diagram of the gear train. Put a circle around the letter in front of the correct answer.

1. Which of these pairs of gears will move in the same direction?

   A. A and B
   B. B and C
   C. B and D
   D. A and C

2. Which of these pairs of gears will move in opposite directions?

   A. E and G
   B. D and G
   C. A and D
   D. B and F
   E. A and C

3. Which of these gears will move in the same direction as gear G?

   A. B
   B. D
   C. E
   D. F
   E. None of these

4. Which of these gears will move faster than gear A?

   A. B
   B. C
   C. D
   D. F
   E. G

5. Which of these gears will move slowest?

   A. B
   B. D
   C. G
   D. F
   E. A

6. Which of these gears will have less power than gear A?

   A. G
   B. F
   C. D
   D. C
   E. B

Exercise 29

SEEING THINGS IN THREE DIMENSIONS

(3-D Visualization--Part 4)

Most of the problems in this exercise are the same as those in exercise 22 of Part C. Be very careful because some of the drawings have been slightly changed and the answers have been rearranged in a different order.

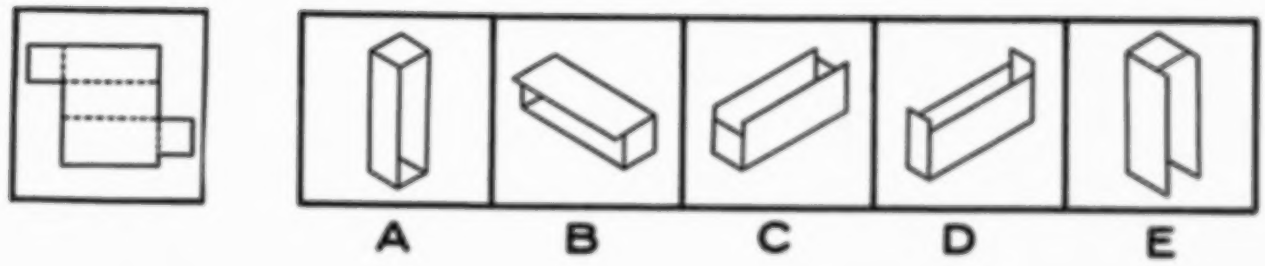
For each problem in this exercise, there will be a drawing of a flat piece of metal at the left. There are five objects at the right. Only one of the objects shown can be made from the piece of metal.

Select the object that can be made from the piece of metal. The solid lines show how the metal is cut. The dotted lines show how the metal is to be folded. No parts overlap. No parts are folded inside of other parts.

When your teacher tells you, turn the page and start the exercise. Circle the letter under the box containing the correct drawing.

Drill 1

1



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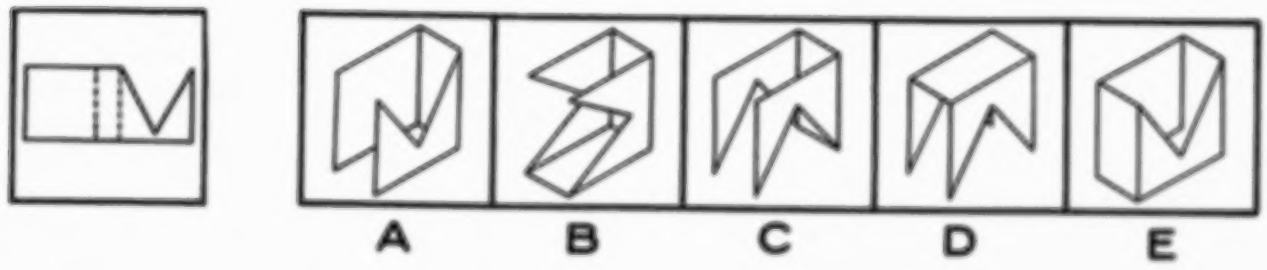

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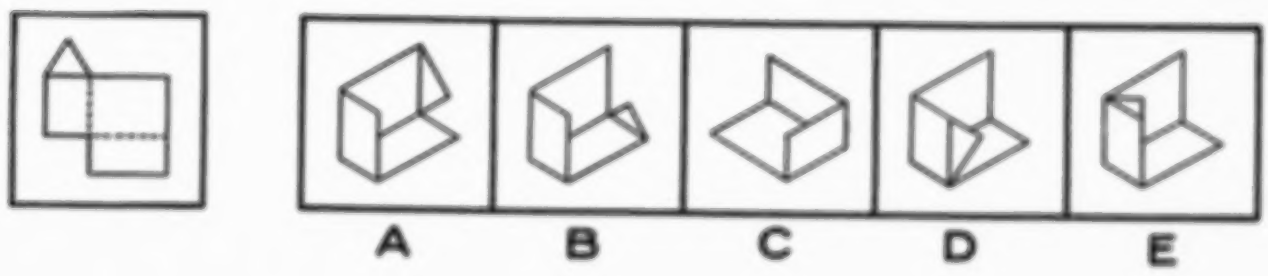

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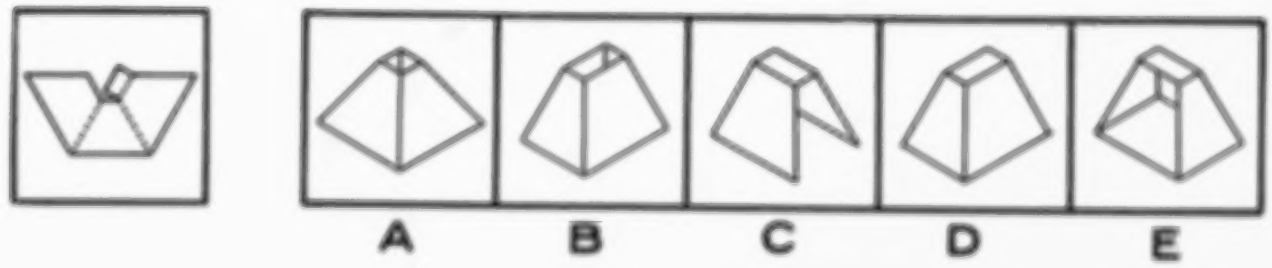

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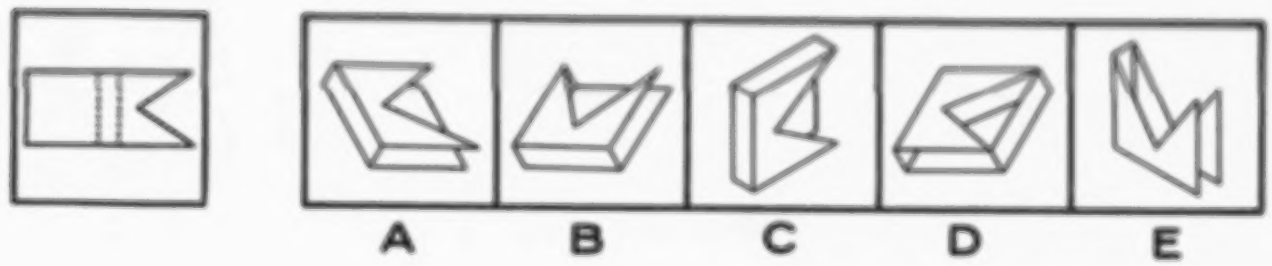

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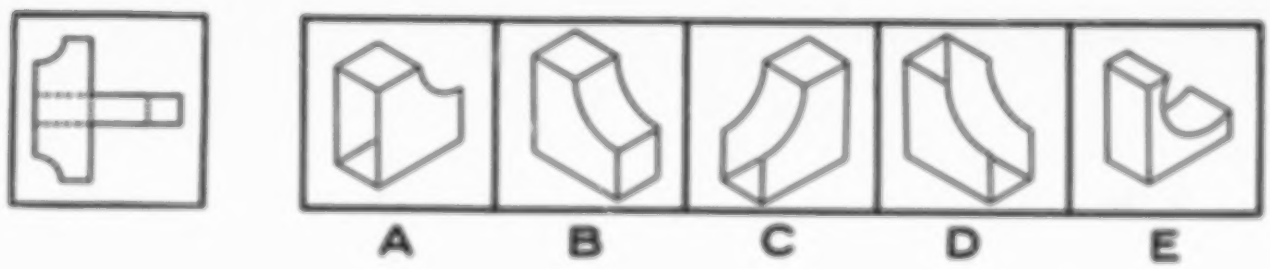

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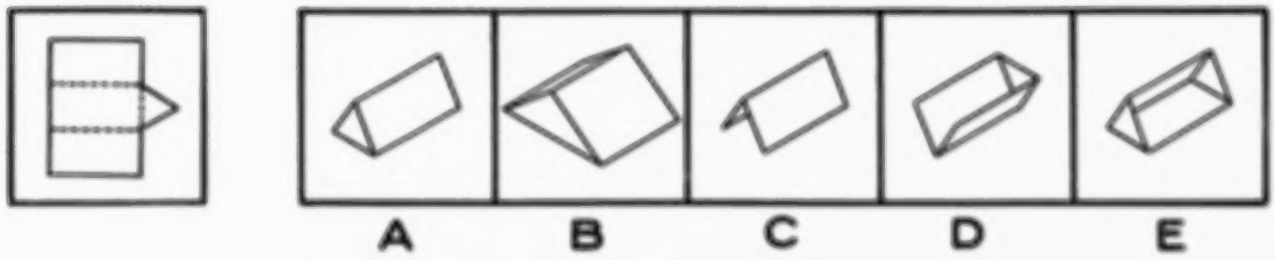

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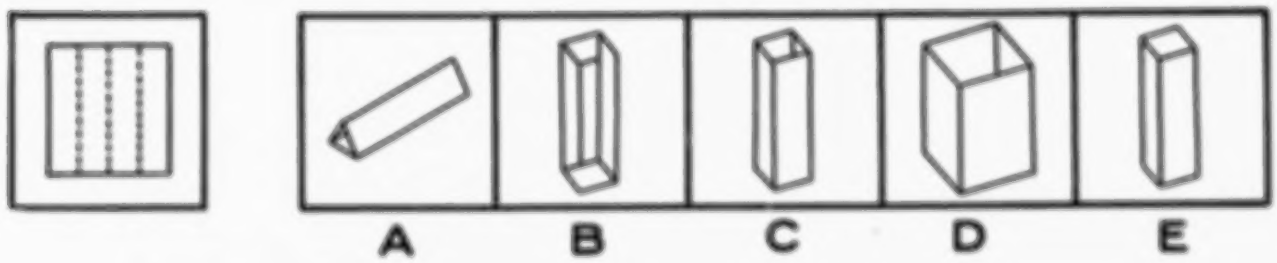

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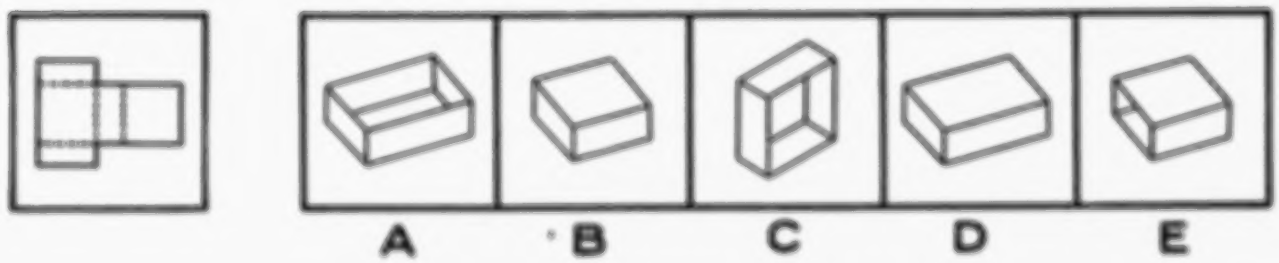

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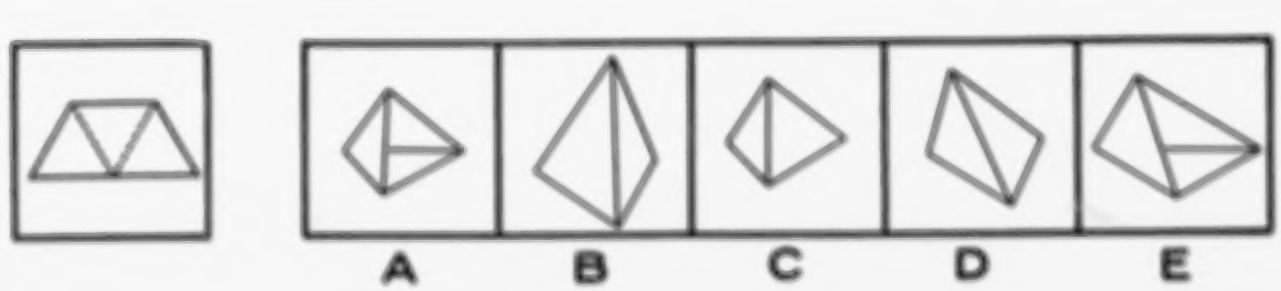

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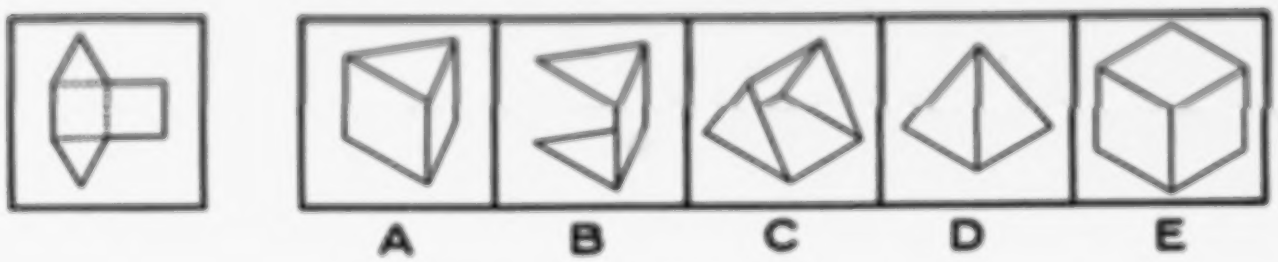

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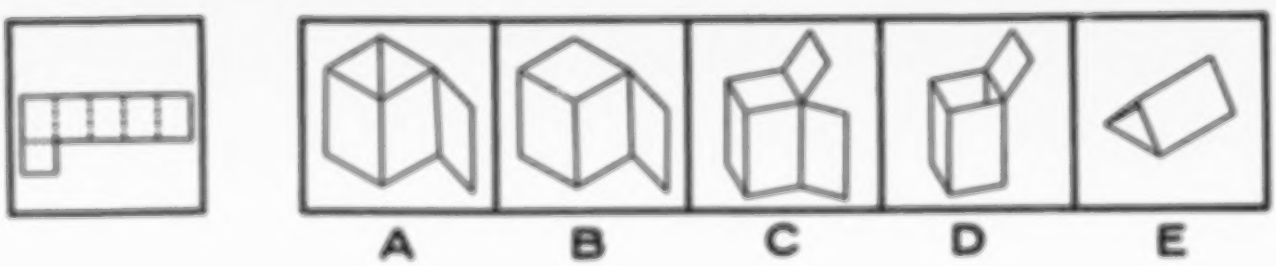

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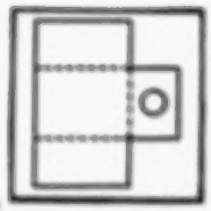

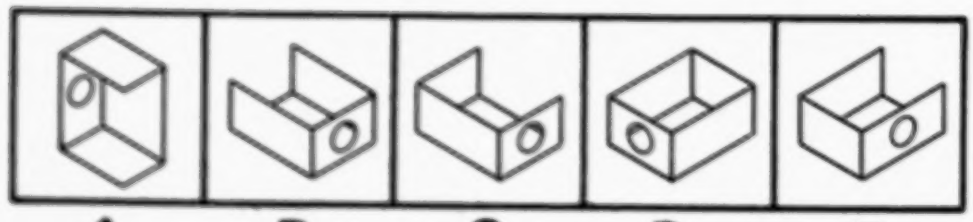

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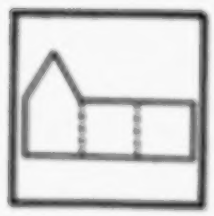

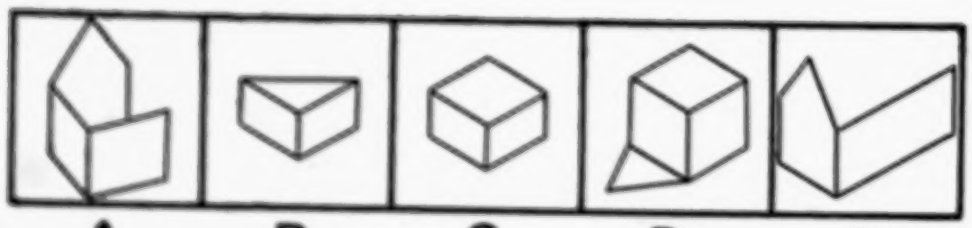

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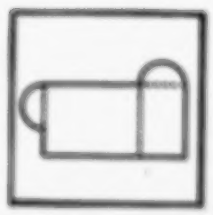

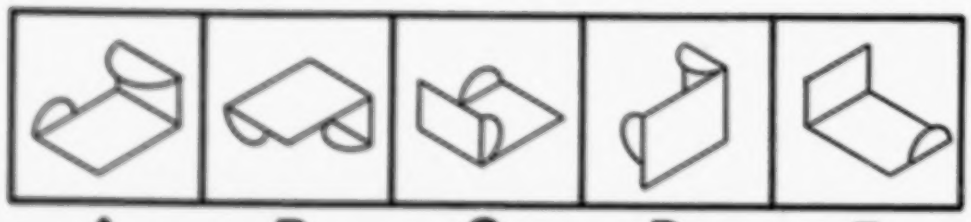

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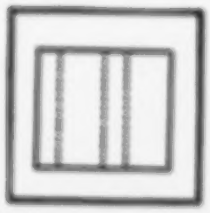

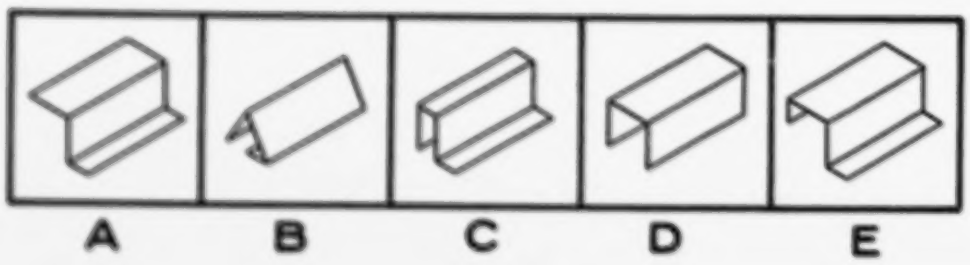

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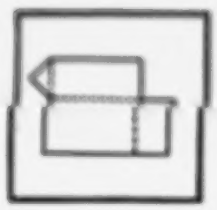

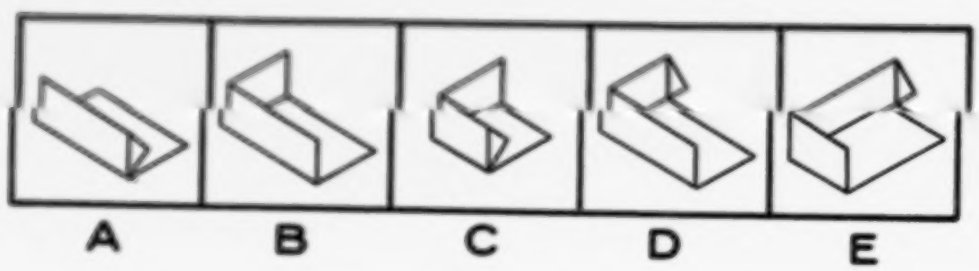

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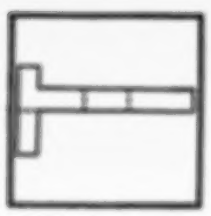
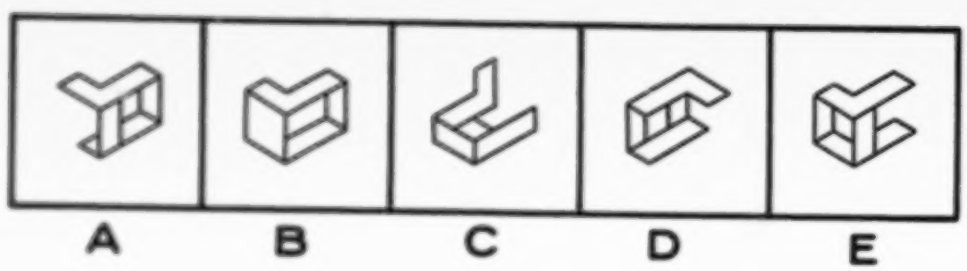
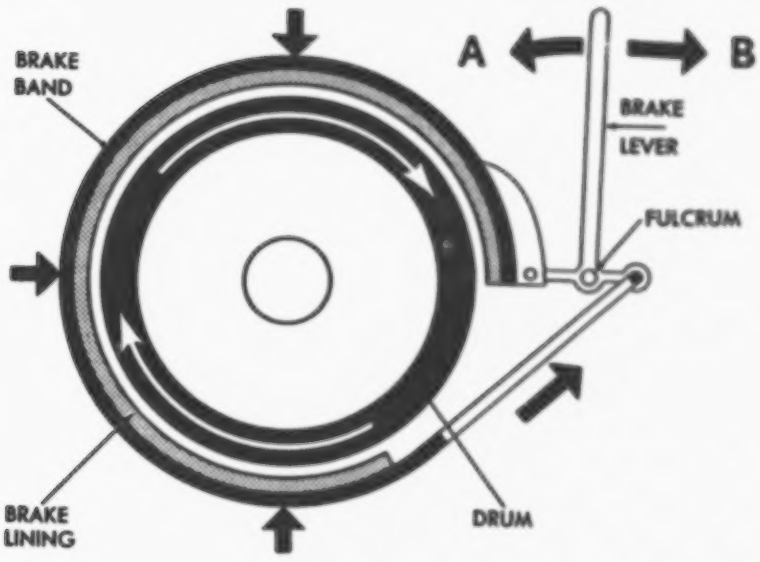




Exercise 30
Part 1

EXTERNAL CONTRACTING BRAKE



This type of a brake is used on many power-driven appliances like winches or hoists. It is sometimes used for parking brakes on automobiles.

The brake drum is shown in the diagram as the heavy line with the two arrows rotating clockwise. The brake band and the brake lining are shown outside the drum, held away from it when the drum is rotating.

When it is desired to stop the drum from turning, the brake lever is pushed in direction A as shown on the diagram. When this happens, the brake band (or shoe) is tightened around the rotating drum. The brake band is made of thin flexible steel which is shaped to fit the drum. The brake lining is riveted to the inner surface of the brake band.

When it is desired to release the drum, the brake lever is moved in direction B. Then the brake lining moves away from the drum.

Exercise 30
Part 1

With this type of brake it is possible to make the amount of braking surface quite large. This is done either by increasing the width of the brake band and lining, or by making the brake drum larger.

QUESTIONS

These questions refer to the diagram of the external contracting brake. Put a circle around the letter in front of the correct answer.

1. To apply the brake, the brake lever should be moved in direction

   A. A (to left as shown).
   B. B (to right).

2. When the brake lever moves in direction B, the brake band becomes

   A. tighter.
   B. looser.

3. Lengthening the brake lever will

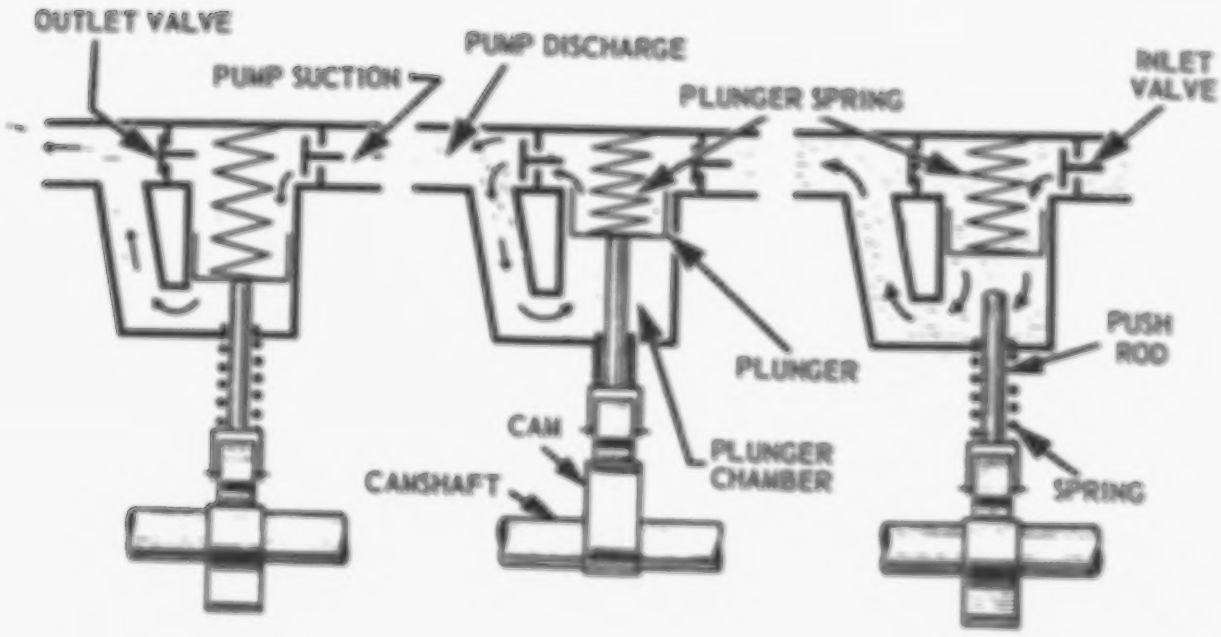
   A. make it harder to stop.
   B. generate less heat.
   C. decrease friction in the brake lining.
   D. make it easier to stop.

4. The fulcrum is a

   A. fixed pivot.
   B. movable pivot.
   C. rigid lever.
   D. stiff bar.

Exercise 30
Part 2

PLUNGER-TYPE FUEL PUMP



The diesel engine has to have fuel forced or injected into its cylinders. The injection pump must be supplied with fuel under pressure because these pumps do not have much suction power.

The fuel supply pump is used to help the injection pump. It pumps the fuel up from the tank. The diagram shows how one type of fuel supply pump works. The three pictures show three positions of the pumping action.

This plunger-type pump is mounted directly on the injection pump camshaft.

In the left picture, the plunger has moved down and is drawing oil in through the inlet valve. This is called the suction stroke. At the same time, fuel is being forced out the pump discharge line to the injection pump.

Exercise 30
Part 2

The middle picture shows that the cam has moved up. The plunger is driven up against the plunger spring. The pressure of the oil above the plunger closes the inlet valve and opens the outlet valve. Oil is forced out through the outlet valve, going back to fill up the space behind the plunger.

The picture to the right shows that the cam has turned from under the plunger push rod. A spring pushes the push rod back against the cam. The plunger spring drives the plunger back to the position shown in the left picture. This return movement of the plunger is the pumping stroke. The pump regulates itself. The supply pressure cannot go above the tension or tightness of the plunger spring. If the injection pump does not need much fuel, only that which is needed will be pumped. When the injection pump needs more fuel, the pumping increases.

QUESTIONS

These questions refer to the diagrams of the plunger-type fuel pump. Put a circle around the letter in front of the correct answer.

1. The figure on the left shows the plunger near the end of
   - A. an injection stroke.
   - B. a suction stroke.
   - C. a compression stroke.
   - D. an exhaust stroke.

2. Oil is drawn in through the
   - A. plunger chamber.
   - B. inlet valve.
   - C. outlet valve.
   - D. push rod.

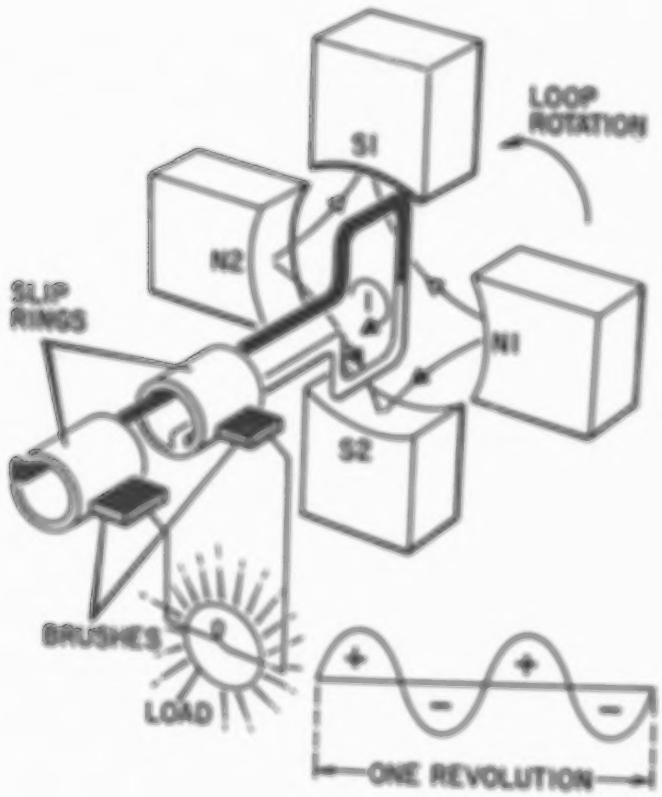
3. In the middle figure, the plunger is pushed against the
   - A. spring.
   - B. camshaft.
   - C. inlet valve.
   - D. outlet valve.

4. When the fuel is put under pressure (middle figure), it is forced through the outlet valve, and next goes
   - A. to the fuel tank.
   - B. to the injection pump.
   - C. back to the inlet valve.
   - D. around to fill the space behind the plunger.

5. In the pumping stroke (right-hand figure), oil is sent into the filter and injection pump, and
   - A. the inlet valve closes.
   - B. the outlet valve is closed.
   - C. new oil is drawn in.
   - D. the plunger pushes upon the spring.

Exercise 30
Part 3

FOUR-POLE A C GENERATOR



The schematic diagram shown here is for a four-pole alternating current generator of basic design.

The diagram shows the basic parts and how the current flows. The basic parts are the two north and two south poles, the rotating loop, and the two slip rings. The outer slip ring is attached to the black side of the loop and the inner slip ring to the white side. The loop rotates in a counterclockwise direction.

This generator converts the power required to turn the loop into current flowing through the wires. This current is used to carry the load shown in the diagram.

Exercise 30
Part 3

The current is generated in the wire when the loop cuts the lines of the force between the poles of the magnet. These lines of force are shown by the curved lines between the north and south poles.

When the loop turns one complete turn, the direction of the current will change four times. This is because the loop passes in front of the four poles. The little drawing at the bottom right shows how the current goes from plus to minus in one revolution.

QUESTIONS

These questions refer to the drawing of the four-pole A C generator. Put a circle around the letter in front of the correct answer to each question.

1. The brushes are in contact with

   A. the north poles.
   B. the south poles.
   C. the loop.
   D. the slip rings.

2. Which way do the slip rings turn?

   A. Clockwise
   B. Counterclockwise
   C. They do not turn.
   D. You cannot tell.

3. Which way do the lines of force flow?

   A. From the north poles to the south poles
   B. From the south poles to the north poles
   C. Clockwise
   D. Counterclockwise

4. If the diagram had three pairs of poles, how many times would the current alternate in one revolution of the loop?

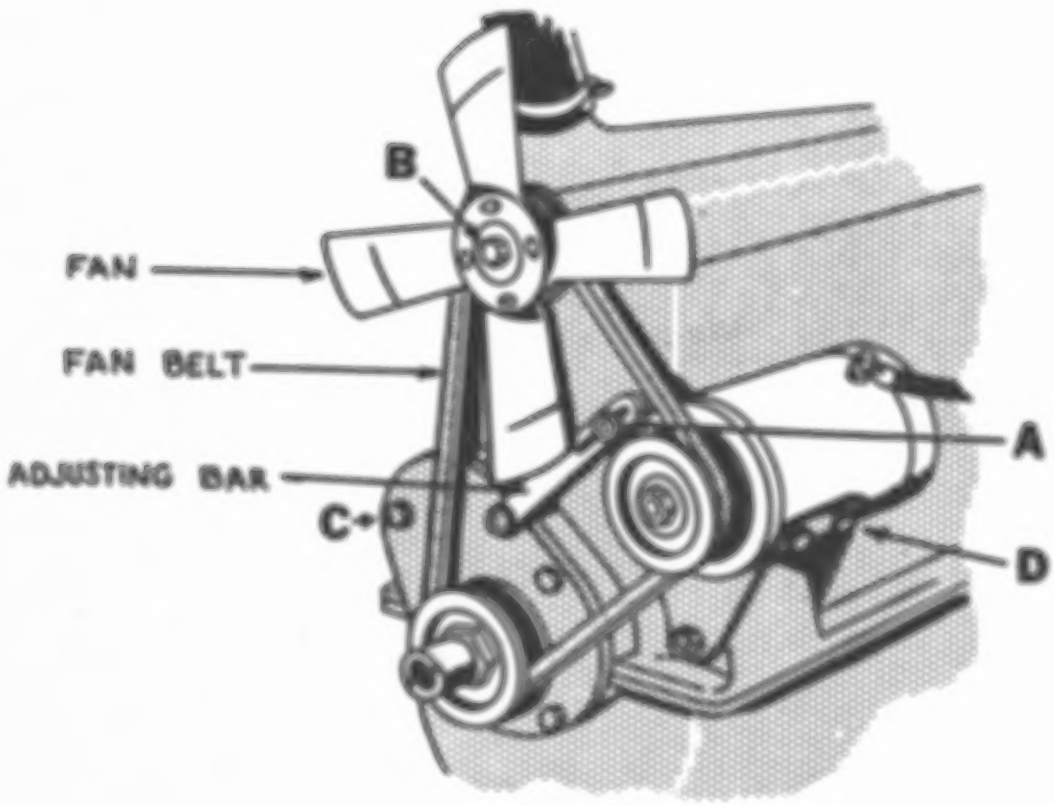
   A. 2
   B. 3
   C. 4
   D. 6

5. Which way do the brushes rotate?

   A. Clockwise
   B. Counterclockwise
   C. They do not turn.
   D. You cannot tell.

Exercise 30
Part 4

AUTOMOBILE FAN BELT



The diagram shows one way of using a fan belt in an automobile. The fan belt connects the fan and the generator drive wheel to the crankshaft drive wheel.

Usually a fan belt is shaped like a V and fits into grooves of a similar shape in the wheels or pulleys it connects. This shape has been found to prevent slipping.

However, when a fan belt gets old and stretches, slippage occurs, and some way must be found to tighten the belt. The diagram shows how this is done. At point A there is a bolt and nut shown in a slot in an adjusting bar. The bolt is connected to the generator housing. When it is desired to tighten the belt, the bolt is moved to the right. This moves the generator with it and tightens the belt.

Exercise 30
Part 4

When a new belt is installed, it will be smaller than the old one, so the bolt needs to be moved to the left a little.

Usually the distance between the fan and the lower drive wheel stays the same. Moving the generator wheel in and out as described is the way the fan belt is tightened.

QUESTIONS

These questions refer to the diagram of the automobile fan belt. Put a circle around the letter in front of the correct answer.

1. What happens when nut A is loosened?

   A. The belt becomes loose.
   B. The fan may come off.
   C. The generator may become loose and vibrate.
   D. None of the above

2. What happens when nut B is loosened?

   A. The belt becomes loose.
   B. The fan may come off.
   C. The generator may become loose and vibrate.
   D. None of the above

3. What happens when nut C is loosened?

   A. The belt becomes loose.
   B. The fan may come off.
   C. The generator may become loose and vibrate.
   D. None of the above

4. What happens when nut D is loosened?

   A. The belt becomes loose.
   B. The fan may come off.
   C. The generator may become loose and vibrate.
   D. None of the above

This is an experimental booklet intended to help young people learn basic principles and concepts of mechanics and technology by means of a series of aptitude training exercises. The exercises are similar to aptitude tests except that an explanation is provided of the underlying principle governing a particular class of items, as well as the correct answer.

This booklet is part of the curriculum and materials for teaching basic vocational talents being prepared under Contract OE-5-85-023 with the United States Office of Education.

Comments and suggestions will be appreciated.

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